TROPICAL AGRICULTURE

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THE COLLEGE'S ACADEMIC OUTLOOK.

MANY beneficial changes and much progress have taken place since the foundation of the Imperial College of Tropical Agriculture as the West Indian Agricultural College in 1921. During its comparatively short life the College has witnessed an extensive building programme and a rapid development of its research activities and educational facilities. Fortunately also the world economic crisis came at a time when the College was almost fully equipped to carry on its existing functions adequately. As there were no immediate prospects for further expansion at that time and in some of the years that followed, the staff settled down to the programme of work laid down with results which it is believed have not been unsuccessful. Recently, the world economic outlook has changed completely and with more prosperous times ahead there are already signs that new demands are about to be made on the College both in respect of training and research. Attention may conveniently be drawn at the present juncture to certain lines of development which may be anticipated as far as training is concerned.

Ever since its foundation the College has provided a three-year diploma course in tropical agriculture. This course is still in existence and has been primarily designed to give instruction in West Indian agriculture; its aim being to provide a sound training for those who intend to make their careers in the Caribbean area. One opening, but only a relatively small one, is Government service in the agricultural departments of the Governments of the West Indies and the Caribbean Colonies. The cadres are small and the vacancies are consequently few. In the last two years, however, there seems to have been an increasing tendency for landowners to send their sons or relatives for training in order that when qualified they may apply scientific principles to the management of their estates on return from College. This tendency is commendable, and if it can be extended will undoubtedly do much to raise the standard of agricultural production in the West Indies. It is a move in the right direction as there can never be enough vacancies in Government service to absorb all our diplomates. Recently there has been an increasing demand for College trained students, and one or two have secured positions carrying salaries and emoluments that are better than those offered by Government Service in the local Agricultural Departments.

Another opening for students lies in the sugar plantation companies. The College possesses its own instructional and experimental factory, and offers an excellent course of training in sugar technology. Qualified students have reasonable opportunities for finding suitable employment, provided they possess certain essential qualifications, among which personality, tact and ability to handle labour count for a great deal. Not all students trained in sugar technology have possessed the necessary temperament for this class of work, but those who did have obtained good positions in sugar factories, and have apparently given every satisfaction to their employers. It is evident that the course of training is satisfactory, provided that the right material for training comes forward.

In recent years, as the work of the College became better known a demand has sprung up from the neighbouring republics on the Spanish Main and from the French Caribbean Colonies. The College is recognised as the leading institution in scientific agricultural work by these countries and it would appear that they have now begun to see the necessity for applying scientific principles to the development of their own agricultural resources. The demand is twofold. The owners of large estates are beginning to send their sons for training with the object of the future development of their family properties; and more recently the Governments of several of the neighbouring republics realising the need for trained men have been enquiring into the possibility of sending their officials for training, with a view to establishing agricultural departments on modern lines. This development, if it does nothing else, indicates that these countries have confidence in the College and its methods. Undoubtedly, the economic depression and the prolonged slump in the prices of agricultural commodities have done much to hinder the movement. The cost of sending students to Trinidad is not small, and with low prices and exchange difficulties it has often been found impossible to send suitable candidates for training, but now that agricultural prices are better, it is expected that there will be a further move in this direction. The other hindrance is the language difficulty. The language of most of these countries is Spanish, and unless the prospective student possesses an adequate knowledge of English he cannot be admitted.

As a recognised British centre for post-graduate training in tropical agriculture, the College so far has catered chiefly for the needs of the Colonial Agricultural Service. During the depression the numbers of scholars appointed fell to about half the previous average, but now that normal expansion can be expected it is presumed that more scholars will in all probability be appointed by the Colonial Office. The Empire Cotton Growing Corporation which has hitherto trained most of its scientific officers here naturally does not send so many scholars now that its cadre is more or less complete. Quite recently, however, the Anglo Egyptian Sudan has decided to initiate a scholarship scheme similar to that of the Colonial Office, and it is reasonable to suppose that one or two students from this source will be forthcoming each year. In the past also a certain number of agricultural officers already in service have been sent for refresher courses, a system which in all likelihood will be continued.

Within the last two years the College has been requested to make arrangements for the training of native agricultural officers from Malaya and Nigeria, and a few of these officers especially selected for their ability and promise will probably be sent for training. As it is possible that these men may not be qualified to take the full post-graduate course, special courses may have to be provided, but this is a matter which is still under consideration.

Thus, taken as a whole, there are healthy signs that an increase in the numbers of students is to be anticipated during the next few years. If this is the case attention will have to be given to such matters as laboratory accommodation and equipment, which will in all probability need extending. If, in addition, special courses are to be undertaken an increase in the staff is indicated, as the existing staff is already fully occupied. The Library which has proved such a valuable asset, has already outgrown the space originally allotted to it. It is obvious, however, that an efficient scientific library is not only essential to the staff and students in their work but also acts as lodestar to workers from other countries. Many eminent scientists have, in recent years, made the College the centre of their investigations for shorter or longer periods, and there can be no doubt that the presence of a good reference library together with laboratory facilities have largely influenced them in making their decision. The visits of these investigators are welcome, as they do much to encourage and stimulate the workers on the College staff.

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THE TREATMENT OF BATHING POOL WATER.

By F. Hardy.
Imperial College of Tropical Agriculture, Trinidad.

There are several objectionable features which may occur naturally in bathing pool water, or which may develop during stagnation. Among these features, the following are the chief:—

(A) Natural objectionable features: (1) muddiness or turbidity, (2) undesirable dark colour usually caused by dissolved organic matter, (3) objectionable taste and smell due chiefly to decomposing organic substances, and (4) occurrence of pathogenic organisms.

(B) Objectionable features developing during stagnation: (1) surface scum, arising from the flotation of suspended or extraneous matter, such as shed leaves, blown dust, &c., (2) floor deposits, often of a slimy nature, produced by the sedimentation of suspended substances or of substances produced by artificial treatments, (3) turbidity, developed by interaction of the water with the material comprising the walls and floor of the pool, (4) development of algae growths, which may float in colonies or may collect on the sides and floor of the pool as a green slime, (5) occurrence of bacterial organisms multiplying during stagnation, (6) objectionable taste and smell caused by artificial treatments.

These objectionable features, and the methods devised by sanitary engineers and chemists to rectify them, may conveniently be dealt with in turn.

(A) Natural Objectionable Features.

(1) *Turbidity.*—This can often be eliminated by a previous settling, straining or filtration through sand. When the muddiness takes the form of turbidity due to very finely-divided suspended particles or highly-hydrated colloidal matter which may be either inorganic or organic, the addition of a suitable flocculent may effect an improvement. If the flocculent be added to the turbid water already in the pool, however, the coagulum settles and produces a heavy deposit on the floor, which may be just as objectionable as the original natural turbidity. This deposit may be removed periodically by the use of a vacuum cleaning apparatus, but the procedure is expensive. It is better therefore to strain or filter the water after treatment with the flocculating agent and before running it into the pool.

Among the most-used flocculents are soluble salts of aluminium or of iron; for example, double sulphates of alumina and alkali metals (alums), aluminium sulphate and iron chloride. These salts hydrolyse in water, generating hydrous alumina (white), or hydrous iron oxide (red brown), which, because of their electro-positive charge, and high adsorptive capacity, combine with the negatively charged suspended impurities and deposit them as a heavy coagulum. The coagulum is easily filterable, and should preferably be removed in a sand-filter before running the treated water into the pool.

The amount of aluminium or iron salt required depends on the initial degree of turbidity, and on the degree of alkalinity of the water. During hydrolysis, acids are liberated from the salts, so that the pH value of the water is diminished considerably. This change in reaction is extremely important in its secondary effects on interactions that may proceed during further artificial treatments, such as the addition of copper salts or of hypochlorites. Thus, natural water which is "hard" because of the presence of excessive lime (calcium carbonate and bicarbonate), is usually somewhat milky in appearance, highly alkaline in reaction, and distinctly blue in colour because of its fine turbidity. Natural water of this sort is common in limestone countries, or in regions where streams flow over limestone outcrops. Generally, the addition of aluminium or iron salt in amount sufficient to change the alkaline reaction to neutrality will completely remove the turbidity and produce a clear sparkling water, but this result is accompanied by the concomitant formation of alumina or iron oxide flocks, which is a serious objection, unless filtration is feasible.

(2) *Dark Coloration.* — When natural water exhibits a brown colour caused by dissolved organic matter (including polyphenolic substances of tannin-like nature, common in peat or humus), treatment with aluminium or iron salt usually eliminates the cause, since the coloured impurities are semi-colloidal and amenable of adsorption and coagulation. In many cases, however, the colouring matter is in true solution and some of it may escape removal unless additional treatment, involving oxidation, is also applied. Occasionally, a resistant or permanent yellow colouration may be altered to a more attractive green colour by the addition of a trace of blue dyestuff, or of copper sulphate.

(3) *Objectionable Taste and Smell.*—Frequently the mere removal of suspended or colloidally-dispersed organic matter improves the taste and smell of natural water, although in many cases, an additional treatment with some oxidizing agent is necessary. Filtration through active carbon (charcoal) often eliminates objectionable smell caused by certain dissolved gases.

(4) *Pathogenic Organisms* in natural water may be partly eliminated by flocculation and filtration through sand, but generally their complete destruction necessitates the use of some bactericide, such as a salt of copper or of mercury [for example, copper sulphate or mercuric chloride (corrosive sublimate)], or the application of some form of chlorination.

Metallic poisons are dangerous if used even in slight excess, and their efficacy depends entirely on conditions favouring the stability of the metallic ion, which is the active bactericidal agent. Thus, under alkaline conditions, copper ions form

insoluble copper hydroxide which settles as pale blue-green flocks, thus resulting in the complete removal of the active metal-ion from the treated water. It is therefore useless to add metallic bactericides to water which is appreciably alkaline in reaction; the reaction should first be adjusted by treatment with some mineral acid, or with acid-hydrolisible salt such as aluminium sulphate or ferric chloride.

Chlorination has proved to be the most satisfactory means of eliminating pathogenic organisms from natural water. Nowadays, the process can be very accurately controlled, so that regulated amounts of chlorine can be added, and excessive doses avoided. The earliest record of large-scale chlorination in Great Britain appears to be that attempted by Sims Woodhead in 1897 during an epidemic of typhoid fever at Maidstone, when bleaching powder was used at the waterworks.* At the present time, seventy-five per cent. of the municipal water supplies in Great Britain and the United States of America are chlorinated.

The bactericidal action of chlorine is remarkably rapid and effective. Thus, 1½ to 2 parts of chlorine per million parts of water will destroy in less than 15 minutes all the organisms in contaminated water containing 30,000 bacteria per cubic centimetre. At one time it was thought that the efficacy of chlorine was due to the high oxidising ability of its solution in water, but this view is no longer tenable. Chemical tests have proved that, although small doses of chlorine may completely sterilise water, a considerable amount of easily oxidisable organic matter of non-bacterial nature still remains unaltered after chlorination. The toxic action of chlorine is probably direct and specific for bacteria, but the true explanation of its effect is not yet forthcoming.

Chlorination may be performed either by adding chlorine gas or a solution of chlorine, or by generating chloramine in the water. The *chloramine process* consists in pre-treatment of the water with ammonia gas or an ammonium salt, such as ammonium sulphate or ammonium chloride, followed after a time by the addition of chlorine gas, sodium hypochlorite, calcium hypochlorite or bleaching powder.

When chlorine is added to water, hypochlorous acid (HClO) and hydrochloric acid (HCl) are formed. Hypochlorous acid, or a hypochlorite, reacts with ammonium hydroxide or ammonium salt to form monochloramine (NH_2Cl), provided the reaction of the treated water is somewhat alkaline. At acidic reactions, dichloramine ($NHCl_2$) or trichloramine (NCl_3) may be produced. Thus, at acidities below pH 4.4, trichloramine is the main product; at reactions around pH 4.5 dichloramine is chiefly formed, whilst at reactions between pH 4.5 and pH 8.5 increasing amounts of monochloramine are produced. In practice, if the reaction of the pool water is maintained between pH 7.8 and pH 8.2*, monochloramine will be the chief product and no free chlorine will be liberated from hypochlorites employed in its production. The strict control of reaction is therefore a very important factor in successful chlorination, and the reaction conditions should be repeatedly checked in order to maintain a high degree of bactericidal efficiency. Alkaline conditions may be attained by the addition of soda-ash in briquette form to the water undergoing treatment, unless the natural reaction of the water is indeed already sufficiently alkaline not to need adjustment.

A complication arises when the water to be chlorinated is both naturally alkaline in reaction and highly turbid because of the occurrence of finely-divided calcium carbonate (limestone "hard" water), since chlorination is best effected at alkaline reactions, whereas the removal of lime suspension necessitates neutralisation or acidification of the water. Water cannot be both alkaline and neutral or acidic at the same time, so that, either the precipitation and removal of the suspended lime must be first effected before chlorination is applied, or else some means of sterilising the water other than by chlorination must be employed. The same objection applies to the use of calcium hypochlorite or of bleaching powder in the alkaline chloramine-soda-ash process; calcium carbonate is precipitated when the calcium compound reacts with the sodium carbonate of soda-ash, and the water becomes cloudy. For this reason, sodium hypochlorite is preferable to calcium hypochlorite and to bleaching powder, although it is more expensive.

(B) Objectionable Features Developing During Stagnation.

(1) *Surface Scum.*—In open-air bathing pools, the collection of surface scums of dust, dead leaves, &c., is almost unavoidable, especially since the pools are usually constructed in places shaded by trees or bamboos. The contamination may be diminished by the provision of high walls or fences, and by over-hung shelters or dressing boxes erected along the windward side of the pool. Bulky surface scum may be removed by frequent drag-skimming of the water surface, otherwise the dead leaves rot and sink, and soon foul the water with objectionable organic matter.

Dust may be prevented by paving or tarring all roads and paths in the neighbourhood of the pool, and by keeping the surrounding land well covered with grassy vegetation.

(2) *Floor Deposits.*—These have already been considered under the heading "Turbidity". The simplest means of removing sediments is to empty the pool frequently and to clean the bottom thoroughly. Vacuum cleaning apparatus may be employed whilst the pool is full, but the volume of the water removed must be made up afterwards by the addition of more water.

*The Chlorination of Water, *Food*, Jan., 1937, pp. 145-148.

*Thresh, Beale and Suckling, "The Examination of Water and Water Supplies", quoted in *Food*, Jan., 1937, p. 148.

(3) *Turbidity*.—The use of cement for lining or facing the walls and floor of bathing-pools is a frequent source of finely-divided calcareous suspension, especially in newly-constructed pools. In due course, as the cement surface becomes thoroughly hardened and weathered, particularly if a thin layer of iron oxide accumulates on it by deposition from the water, corrosion diminishes and the objectionable feature gradually disappears, but the process may take many years. Pools supplied with lime-free " soft " water may develop turbidity by contact with fresh cement or concrete within a day or two of filling. The cloudiness may easily be eliminated by adding an aluminium or iron salt, but it may reappear later, and may recur each time the pool is emptied, cleaned and filled.

(4) *Algal Growths*.—These are a constant source of contamination in open-air bathing pools, especially in the tropics where sunlight is intense and the days are relatively long. Some relief may be obtained by suitable shading. Copper and mercury salts, applied when the water is neutral or slightly acidic, may alleviate the nuisance, or, better still, chlorination may be employed to destroy the algal spores. When the pool is emptied, the walls should be allowed to dry completely, and the surface should then be scrubbed. This process, however, may expose the cement and cause turbidity when the pool is refilled. Spraying the walls of the empty pool with a concentrated solution of copper or mercury salt may be attempted as an alternative, but the cost of the operation may be prohibitive. The most satisfactory method in the long-run undoubtedly is proper chlorination.

(5) *Bacterial Organisms*.—Whilst the immediate effect of chlorination is to reduce the number of viable bacteria, a great increase in bacterial numbers may occur after a few days. This phenomenon is known as " aftergrowth " ; it is particularly liable to occur when the water contains organic matter, but it is confined to soil and water bacteria, and is *not* exhibited by pathogenic organisms such as *Bacillus Coli*, causing typhoid fever.*

(6) *Taste and Smell caused by Chemical Treatments*.—Some natural waters after chlorination possess an undesirable "chemical " taste and smell which resemble the taste and smell of iodoform. This feature is stated to be caused by the formation of chlorophenols by the interaction of organic impurities with chlorine. Thus, one part of a phenolic substance in ten million parts of water may produce this particular taste and smell when the water is chlorinated. The source of the phenols may be certain kinds of vegetation, certain oil-bearing algae, and the oil or tar used for building roads or dams over which the water may flow.

Objectionable " chemical taste " is said not to be developed when the chloramine process is practiced.

* Pale pink colouration with phenolphthalein indicator.

The excessive use of chlorine gas or of hypochlorites in the chlorination process may also give rise to an objectionable taste and smell, particularly if the process is applied to neutral or acidic water to which no alkali or ammonium compound has been added. Excess of chlorine is objectionable in that it attacks the mucous membranes of the eyes, nose and throat, causing smarting, but if care be taken in chlorinating the water, no such properties should develop. Excessive chlorination may be corrected by adding sulphur dioxide gas to the water. Generally when the water is chlorinated so that it contains about two parts of chlorine to one million parts of water, no objectionable features develop ; reliable chemical tests are available for checking the process, and mistakes may usually be easily rectified. In any case, all chemical treatments applied to natural waters, whether for the purpose of producing potable water or bathing-pool water, should be carefully checked by chemical tests, among which the frequent periodic measurement of pH value should invariably be included.

Example of Quantitative Treatment of Bathing Pool Water.

As an illustration, the following summary of the procedure employed in keeping an indoors school swimming pool clean and wholesome, may be offered.* The pool in question has a volume capacity of 370,000 gallons (which is about 3½ times that of the open-air pool at the Imperial College of Tropical Agriculture in Trinidad). In order to obtain entirely satisfactory results whilst the pool is in constant use by a large number of persons, (1) the floor of the pool is vacuum-cleaned daily, (2) the high-water mark and the scum-gutter are scrubbed daily, (3) the pool water is circulated for eight hours a day through a sand filter, (4) the reaction of the water is adjusted daily to between pH 7.8 and pH 8.2 by the addition of soda-ash, two to four pounds weight of the substance being required for each daily addition, (5) sodium hypochlorite is added daily, two to three quarts of a 9 per cent. solution being required [calcium hypochlorite, although cheaper, produced an undesirable white turbidity through the formation of calcium carbonate by interaction with the added soda-ash (sodium carbonate)].

Evidently here, the *chloramine process* was not employed. Presumably just as satisfactory or even better results could have been obtained by first adding ammonium hydroxide or an ammonium salt, followed later by the addition of sodium hypochlorite or calcium hypochlorite to the alkalinized pool water. Theoretically, one part of ammonia (NH_3) is required for every 4 parts of chlorine to form monochloramine, but in practice, one part of ammonia to 3 parts of chlorine is generally sufficient. The amount of hypochlorite needed in order to produce the recommended concentration of 2 parts of chlorine per million parts of water depends on the amount of available

* *Journ. of Chem. Education*, Dec., 1936, Vol. XIII, p. 576. Article by E. A. de Windt, of the Principia College, Elsah, Illinois, U.S.A.

chlorine in the compound. This is generally about 65 per cent. of the total chlorine content. Thus, the amount of pure calcium hypochlorite required to give 2 parts of available chlorine theoretically is 6.2 parts by weight. Hence, to every million parts of pool water, 6.2 parts of calcium hypochlorite should be added, together with its equivalent of, say, ammonium sulphate, which is about 2 parts by weight It therefore follows that 1,000 gallons of pool water (10,000 lb. weight) would require 0.02 lb. ($\frac{1}{3}$ oz., or 9 grams) of ammonium sulphate and 0.062 lb. (1 oz., or 28 grams) of calcium hypochlorite* for effective chlorination by monochloramine at a reaction of about pH 8.2. Actually, the required dosage of hypochlorite should be checked by periodic chemical tests, the object generally being to maintain an *excess* of about 0.2 to 0.5 parts of available chlorine per million parts of water in the pool. Amounts greater than about $1\frac{1}{2}$ to 2 oz. of calcium hypochlorite per 1,000 gallons of pool water are seldom required in practice, so that the cost of chemical treatment is not exorbitant, and should not exceed two pence per 1,000 gallons of water to be treated each time the pool is emptied and refilled.

* A suitable dry powder form of calcium hypochlorite may be purchased from chemical manufacturers at the cost of about 1*s.* 6*d.* per pound in cans of 4 lb. weight.

A MOBILE SCALE FOR WEIGHING SUGAR CANE ON EXPERIMENTAL PLOTS.

By Cecil F. Charter.
(*Agronomist, Gunthorpes Estates, Antigua.*)

At the Fifth Congress of the International Society of Sugar Cane Technologists, A. M. O'Neal presented a paper describing a portable scale for weighing sugar cane on experimental plots. A similar apparatus and procedure has been adopted to reap experiments laid down on behalf of the Antigua Sugar Cane Investigation Committee.

During the 1935 and 1936 crops a gallows supporting a block and endless chain, a steelyard graduated up to 2,500 lbs., and a cradle to hold the cane was used by the writer. The gallows was a massive affair. It had to be dismantled in order to transport it to a fresh experimental sites, and could be moved about on experimental areas only with difficulty. In consequence the weighing apparatus was moved as infrequently as possible during the reaping of an experiment, and the canes from the various plots had to be headed to the scale, a somewhat laborious procedure. After it had been weighed, the cane was thrown in a large heap behind the scale which rendered it troublesome for the estate carts to pick up. It became evident that it would be necessary to adopt a more rapid and less expensive method of reaping.

An apparatus similar in most respects to that described by O'Neal was therefore constructed. This consists of an old front axle of a motor car with wheels and tyres. A four-inch by four-inch mora tongue, ten feet long, is clamped to the axle, and a four-inch by four-inch mora post is bolted and braced to the tongue just over the axle as shown in Fig. 1. A horizontal beam, four inches by four inches and four feet long is joined and braced to the top of the upright post, and from this a steelyard is suspended. A steel cradle of the type illustrated has been found convenient; this is capable of holding fourteen hundredweight of cane; usually only about half this amount is weighed at a time. Apart from the steelyard, such an apparatus, capable of standing a considerable amount of rough handling, can be constructed for about $78, inclusive of new tyres and inner tubes.

In the experiments laid down by the writer, cane is grown on five-row or six-row beds. The stools are cut in such a manner as to leave two windrows of cane along the beds separated by a central windrow of trash. The mobile scale travels up the trash windrow in the centre of the bed. The cane after being cut is cleaned by a gang of girls and tied up into bundles weighing about fifty pounds with tared ropes. Eight of these bundles are placed on either side of the cradle by the boys working the scale, the weight recorded, and the cane placed back on the trash-free windrow by the side of the scale which is then moved forwards. The tying facilitates the handling of the cane and ensures its being left behind in a tidy heap easy for the carts to pick up.

By this method it has been found possible for two such scales to keep pace with ten cutters of average speed, and for one officer to superintend the accurate harvesting of a large experimental crop, without other skilled assistance. Using mobile scales in this manner, about 32 tons of cane can be reaped and weighed in an eight-hour day, whereas previously it was only possible to deal with half this quantity. Each scale is attended by three boys and five girls.

The method now used has commended itself to the estates as it leaves the cane in windrows along the beds so that the carts can pick it up with ease, and because it does not impede the routine of estate operations, the cutters being able to cut cane at the same rate under ordinary conditions. This scale has the merit of being easily moved from plot to plot and from estate to estate, and in addition is proving useful in the careful weighing of bulky manures, such as filter-press mud and pen manure, for application to experimental areas.

Reference.

O'Neal, A. M. (1935).—"Portable Scale for Use in Weighing Sugar Cane on the Soil Fertility Experiments in Louisiana." *Proceedings of the International Society of Sugar Cane Technologists*, 5th Congress, Brisbane, p. 797.

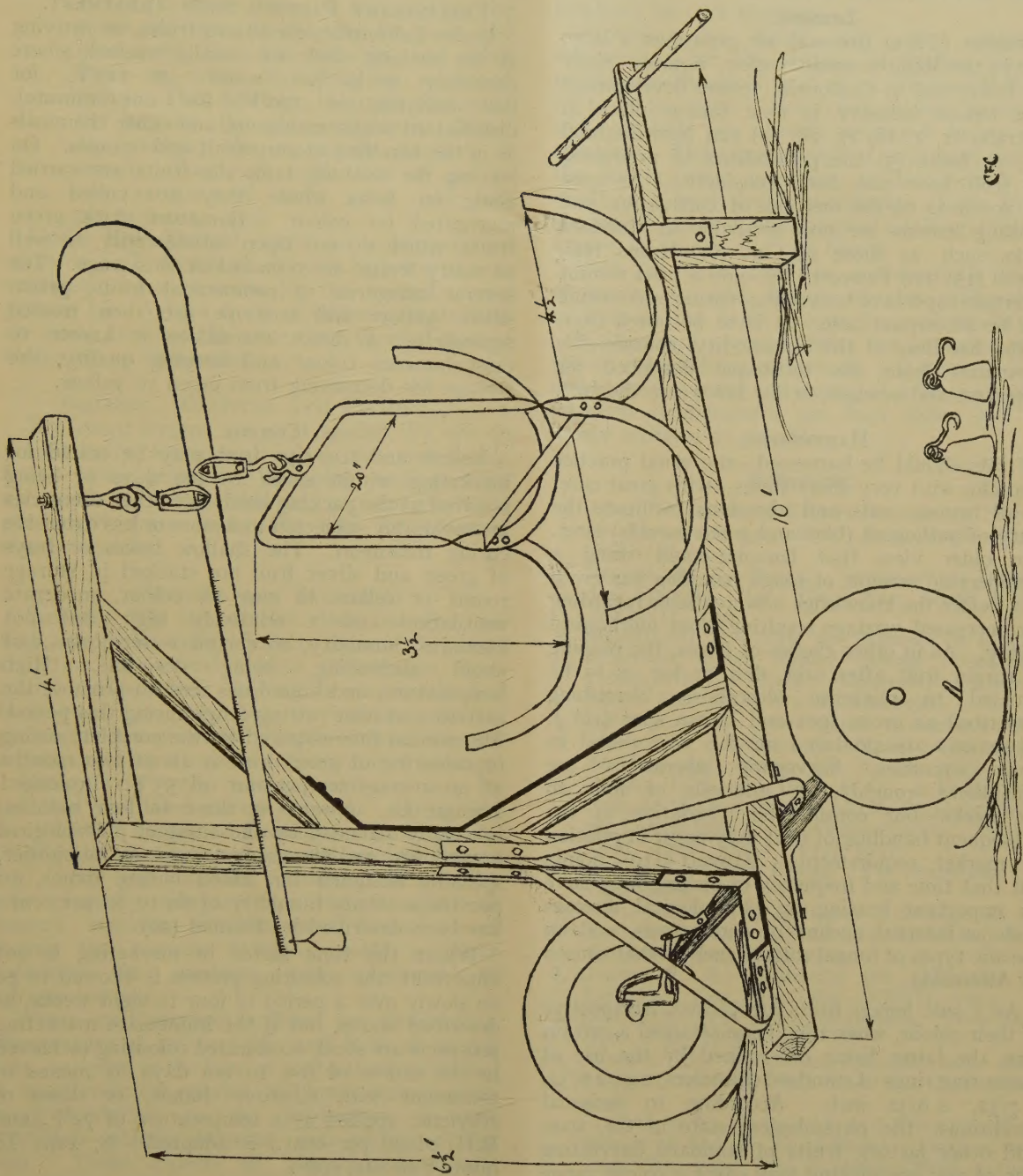

FIG. 1.—MOBILE SCALE FOR WEIGHING SUGAR-CANE ON EXPERIMENTAL PLOTS.

TROPICAL FRUITS AND VEGETABLES. AN ACCOUNT OF THEIR STORAGE AND TRANSPORT.

By. C. W. Wardlaw.
Low Temperature Research Station.

Continued from *Tropical Agriculture*, XIV, 6, 1937.

Lemons.

Lemons (*Citrus limonia*) are grown on a large scale in the Mediterranean region, notably Sicily and Italy, and in California. Some development of a lemon industry is now taking place in Australia (1, 2, 16, 17, 18, 21) and New Zealand (9); in India (5) the possibilities of producing this fruit have also been considered. As very full accounts of the methods of cultivating and handling lemons are now available in standard works such as those of Coit (6), Hume (12), Powell (15) and Fawcett (10), only a brief resumé of certain aspects of harvesting, curing and storing will be attempted here. It is to be noted that, in the handling of this commodity, considerable departures from the technique described for grapefruit and oranges, or for limes, are the rule.

Harvesting.

Fruits should be harvested—the usual practice is to clip with very short stems—with great care, as all bruises, cuts and abrasions facilitate the entry of pathogens (blue and green moulds) later. The older view that lemons could stand a considerable amount of rough handling has given way before the knowledge now available regarding the increased wastage resulting from mechanical injury. As in other classes of citrus, the reaping of turgid fruit after rain, dew or fog, is to be avoided to minimise oleocellosis blemishing (described as green spot and brown spot (10)). As lemons are produced all the year round in some countries, harvesting operations are continuous—roughly, at intervals of four to six weeks—but considerable variation in the subsequent handling of fruit may occur in relation to market requirements. Fawcett (10) points out that time and frequency of picking may have an important bearing on physiological diseases such as internal decline or endoxerosis, and on specific types of fungal rotting such as that caused by Alternaria.

As a rule lemon fruits are picked, irrespective of their colour, when they have attained a certain size, the latter being determined by the use of measuring rings of standard diameters, e.g., 2 6/32, 2 7/32, 2 8/32 inch. According to seasonal conditions, the physiological state of the tree, and other factors, fruits of standard harvesting size at any one picking may cover a colour range described as "green", "silver", "yellow", and "tree-ripe", the best lemons for marketing being those picked green and cured in storage: yellow and tree-ripe fruits, on the other hand, usually have poorer flavour and keeping quality. A preliminary wilting period of three to ten days, according to humidity, is usually allowed before fruits are removed from the field boxes.

Preliminary Packing Shed Treatment.

Under Californian conditions fruits, on arriving at the packing shed, are usually washed, where necessary with hot water (at 115°F. for two minutes, or 120°F. for one minute), disinfectant soaps, emulsions, and other chemicals as in the handling of grapefruit and oranges. On leaving the washing tank the fruits are carried along on belts where they are culled and segregated for colour. Immature, dark green fruits, which do not ripen satisfactorily, as well as wasty fruits, are removed at this stage. The several categories of commercial fruits, green, silver, yellow and tree-ripe, are then treated separately: a direct correlation is known to exist between colour and keeping quality, the storage life decreasing from green to yellow.

Curing.

Yellow and tree-ripe fruit may be crated for marketing within seven to ten days of being received at the packing shed, but other categories are invariably subjected to a more or less extensive curing treatment. The shallow boxes or trays of green and silver fruit are stacked in storage rooms or cellars to cure or colour, moderate ventilation and a relatively high, but not excessive, humidity, to curtail water losses and avoid shrivelling, being desirable. High temperatures and humidities tend to promote the activities of fruit rotting fungi during this period. The normal time required for the complete curing or colouring of green fruit is about two months at an average temperature of 55°F. Prolonged storage, *i.e.*, upwards of three to four months, is usually attended by the onset of physiological breakdown and fungal rotting. A humidifier, specially designed for lemon curing rooms, to provide a steady humidity of 80 to 90 per cent., has been described by Shamel (20).

Where the time factor in marketing is not important, the colouring process is allowed to go on slowly over a period of four to eight weeks, as described above, but if the immediate marketing prospects are good, accelerated colouring (achieved in the course of five to ten days by means of treatment with oil-stove fumes, or doses of ethylene, applied at a temperature of 72°F. and R.H. of 90 per cent.) is adopted. (8, 10). To quote Fawcett, (10):

> Denny found that forced curing is accompanied by greatly increased respiration. The life processes are stimulated, and usually an abscission layer is formed that results in the loss of the buttons. Waxing the fruit or spraying with a medium, or heavy, oil spray a few weeks or months previous to the use of ethylene tends to

retard respiration and colouring as compared with unwaxed or unsprayed fruits. It has been found that certain forms of physiological breakdown are greatly aggravated by forced curing, more especially the red bloch, albedo browning, and, to some extent, membranous stain. If the gas is too strong, it may weaken the tissue and open up the way for green and blue mold, the stem-end rots, and other forms of decay depending on weakened tissue. This, however, is largely prevented by keeping the gas sufficiently dilute. In practice, the maximum strength is usually about one cubic foot of gas to one car space of about 5,000 cubic feet per 24 hours. (10).

Under New Zealand conditions a temperature of 50° to 60°F. and R.H. of 80 to 85 per cent. are considered most suitable for the normal curing process (9). Where fruits of different maturities are being cured at the same time, divided storage rooms are an advantage.

Grading, Wrapping and Packing.

The cured lemons are next graded, by eye or mechanically, for size, all wasty and undesirable fruits being rejected. Wrapping and packing operations are then carried out, 300 and 360 fruits per bulged crate being the rule for common standard packs.

Storage and Transport.

Provided the temperature does not rise too high, properly cured lemons remain in good condition for several months in common, non-refrigerated storage; as long as six months has been cited (17, 18); but, as indicated above, prolonged storage of fully matured fruit may be accompanied by a considerable amount of wastage.

During very warm weather, rail-cars may be iced, but ventilated storage is usual: during cold weather the danger of freezing is minimised by closing the ventilation ports. Mann and Cooper (14) found that standard ventilation in rail cars was generally adequate for the transport to eastern markets of Californian lemons, even during the warmer months: only a slight reduction in wastage was observed in refrigerated cars.

Where cold storage facilities are available a temperature of 50° to 55°F. and R.H. of 90 per cent., supplied in the form of air-blast refrigeration, is considered most suitable (19), lower temperatures being conducive to the production of chill blemishes— chiefly blotches and pitting of the rind. These aspects of physiological injury have been treated in detail by Fawcett (10); in general they are comparable with the types of chilling injury already described for grapefruit and oranges. Fawcett, Klotz and Nixon (11) have shown that lemons showed less decay under air conditioned refrigerated storage than under natural ventilation at the same average temperature.

Calcat (4) has recorded that Algerian lemons may be preserved for three to four months by the following treatment: sound fruits are dipped in milk of lime, removed almost immediately and allowed to drip; they are then placed in cases and held in a cool place at constant temperature, the successive layers of cases being insulated by cork shavings.

According to Koch (13), the optimum temperature for the storage of Italian lemons received in Russia is 37.4° to 39.2° F. and R.H. of 65 to 70 per cent.; this refers to fruit in which some wastage has already appeared during rail transport. Defective storage of such fruit during the winter, may, according to Bondartzeff (3) result in a considerable percentage of the fruits showing the type of physiological (chilling) injuries known as peteca and red blotch.

Delft (7) states that the anti-scorbutic value of lemons in cold storage remains unimpaired as long as the fruits remain in good condition.

In basement storage rooms not provided with special refrigeration equipment, a system of daily and nightly opening and closing of doors is adopted whereby temperatures are kept down and as nearly uniform as possible.

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Limes.

Commercial Utilisation.

The lime (*Citrus medica* var. *acida* = *C. aurantifolia*), considered to be native to India and south east Asia, is now cultivated extensively in the British West Indies, Porto Rico, Cuba, Florida, Mexico, West Africa, the Philippine Islands and India. In the tropics, for domestic purposes, the lime is more or less the equivalent of the lemon in temperate lands. Commercially the fruit is important as a source of raw lime juice (for the preparation of cordials and beverages, citrus acid and sodium citrate) and lime oil. During recent years, however, it has been found more profitable to manufacture citric acid from molasses, and accordingly it has become necessary to find new outlets for limes, particularly in the West Indies, where extensive plantations have long been established, and in the Gold Coast where plantations are now developing (4, 5). Attempts are therefore being made to increase the export of fresh green or yellow limes and to popularise the fruit on new markets (2, 3). This may involve competition with the relatively inexpensive Sicilian lemon; the more favourable alternative is that green limes may find a place on the market as a distinctive tropical fruit (5). The advantages to the grower of marketing fresh green limes have long been advocated (1). From the storage data obtained in Trinidad (6, 7) the conclusion has been reached that no serious difficulty should be experienced in shipping limes to distant markets provided certain conditions are observed.

For many years limes have been exported from the British West Indies to the United States and Canada, packed in barrels weighing 160 to 180 lb. and containing about 1,500 fruits. This system of export is now considered undesirable (2), the modern view being that fruit should be packed in 24 lb. lugs (the standard flat tomato lug) and shipped as refrigerated cargo, so that the full piquancy and attractiveness of the fruit may be preserved.

Hybrid Limes.

The susceptibility of the West Indian lime to Wither-tip Disease has necessitated the breeding of new varieties (9). By crossing the Philippine lime which more resembles a small lemon than a lime, with the West Indian variety, a number of hybrids, immune or highly resistant to Wither-tip, have been obtained in Trinidad. One of these, known as the T1 lime, is a fruit of good appearance, juice and oil content and is now being cultivated and marketed on a not inconsiderable scale. A second hybrid, T6, possesses less favourable commercial qualities but has considerable botanical interest when studied along with the T1 hybrid and the parental types. All four exhibit considerable differences in the matter of loss in weight during storage under identical conditions. Thus, weight for weight and grade for grade, the two hybrids, T1 and T6 suffer more seriously from desiccation than either of the parents (*i.e.*, the West Indian and Philippine varieties). Again, in the matter of cold-resistance, considerable differences have been observed, the Philippine lime proving most resistant and the hybrid T6 least; the hybrid T1, on the other hand, is apparently more cold-resistant than the West Indian lime. Such variations are interesting in that they indicate the unexpected rearrangements of physiological characters which may result from hybridisation.

Picking and Handling.

The delicate skin of the lime is very subject to mechanical injury. Great care in packing and handling at all stages is therefore essential. It is well known among fruit growers that if limes are picked after a spell of rain or while still covered with dew, they are liable to an unsightly skin spotting or blemishing (*oleocellosis*) which develops four or five days later.

Grading: Experimental Observations.

Experiments were undertaken in Trinidad (6, 7) in 1933 to determine: (i) the correct stages of maturity at which to pick for (*a*) green lime markets and (*b*) yellow lime markets; (ii) optimal temperature and humidity during the period of transport and distribution; (iii) temperature requirements to prolong the marketing season; (iv) physiological behaviour of the several different varieties which may be exported; (v) the best methods of handling, wrapping and crating.

Five varieties were used in these studies; namely the West Indian lime, the East Indian lime, the Philippine lime, the Trinidad Hybrid (T1), and a second Trinidad Hybrid (T6). In preliminary experiments (7) it was shown that limes graded for size under the usual commercial system and held in cold storage at 45°F. for varying periods, tend to develop considerable uneveness in colouration, *i.e.*, it was evident that greater standardisation for colour and maturity was required.

Later it was found convenient to grade fruit as follows (6): A, fruit more or less completely yellow on picking; B, fruit with greenish-yellow intermediate colour, *i.e.*, "turning"; C, full-grown, pale-green (the pale-green colour is preparatory to "turning"); D, full-grown or almost full-grown but dark-green; E, smaller dark green fruit; F, small immature fruits. As the several varieties show considerable differences in their physiological behaviour, these arbitrary grades do not necessarily denote complete similarity when different varieties are being compared. In general, while there is a correlation between size of fruit and maturity, this is not absolute, as indicated by the uneven ripening of machine-graded samples.

Maturity and Keeping Quality.

Picking at the correct stage of maturity is of fundamental importance if the best use is to be made of the several varieties. In general, four grades (A, B, C and D, as described above) may be regarded as falling within the commercial range, but each variety must be treated on its own merits. Thus, while East Indian and West Indian limes may be selected from four grades of maturity (A, B, C and D), hybrid T1 limes can only be selected from the first three grades.

As limes undergo little colour change during cold storage, fruits for particular markets may be picked at approximately the required stage. Thus if yellow limes are to be marketed, West Indian, Philippine, and T1 varieties should be picked when almost full yellow. Fruit of this maturity is not only exceedingly juicy but it has an attractive appearance and possesses good keeping quality. With care such fruit may be kept at 45°F., with negligible wastage, for two months or more if required.

Limes picked "turning" (Grade B) tend to be nondescript at the end of the storage period and being of mixed appearance do not satisfy trade requirements. If desirable, no outstanding difficulty should be experienced in curing such fruit (high humidity at 70°F gives good results). In limes picked full-grown, pale-green, some irregularity in the appearance of packs may also be experienced if storage is prolonged. By picking West Indian limes full-grown but dark-green in colour, this is usually avoided, and standard packs of attractive fruit may be held in storage for a long period, 40 to 50 days if required. With the T1 hybrid, on the other hand, fruits below Grade C (full-grown, pale-green) are definitely immature and exhibit poor keeping quality; T1 limes for green-lime markets, therefore, should be picked at Grade C or just a little less mature. This variety usually produces fruits of very uniform size, and can be graded with great ease. Furthermore, as it crops abundantly throughout the year, precautions for prolonged storage are unnecessary; T1 limes are also suitable for the yellow lime industry. The Philippine lime comes more into the lemon category and need not be considered in greater detail here, other than to call attention to its sound storage qualities.

Storage Temperature.

A temperature of 45°F. is well suited, not only to the several varieties, but also to green and yellow limes of the same variety (6). At 40°F., the several varieties under consideration were subject to chilling injury, in the form of an unsightly pitting or blotching of the rind, closely resembling that described for grapefruit and oranges, the extent of the blemishing being accentuated by desiccation. Immature fruits are most subject to chilling. No aspect of internal decline or breakdown has been observed.

Humidity.

The storage of limes exemplifies in particular the importance of the humidity factor (6). In its freshly picked state, the green lime is hard and turgid and possesses a bright, shiny and attractive appearance. When exposed to a relatively dry atmosphere, however, fruits gradually become dull-coloured, wrinkled and dry with a dry surface texture; they undergo softening and in some instances localised blemishes or blotches may appear or a hard, leathery skin may be produced. Considerable losses in weight accompany these changes. In general, limes are more difficult to handle than lemons, being more liable to wastage through shrivelling; the avoidance of desiccation, indeed, is one of the major problems in the storage of this fruit. Being of small size, and therefore presenting a relatively large transpiration surface, fruits become noticeably shrivelled when they have lost 12 to 14 per cent. of their original fresh weight, and since desiccation takes place very rapidly at tropical temperatures (1.5 to 2.0 per cent. of the original fresh weight per day), the commercial storage life, as limited by the onset of shrivelling, may be seriously curtailed by any undue delay whilst fruit is waiting to be graded and packed at high temperatures (approximately 80° to 85°F. under West Indian conditions). Speedy handling, protection against excessive desiccation and rapid cooling to 45°F. are essential to the successful marketing of limes.

When exposed unwrapped to air-blast refrigeration, the several varieties and grades show marked differences in the matter of loss in weight. As a rule, the more mature grades show least decrease in weight and the less mature most. The hybrids T1 and T6, with the exception of yellow T1 limes, showed greater percentage losses in weight, grade for grade, and weight for weight, than did either of the parents (the West Indian and Philippine varieties).

As rate of loss in weight is directly related to the dryness of the air, it is advisable that the atmosphere in storage rooms should be maintained at a relative humidity of not less than 85 to 90 per cent. Quailing or wilting fruit for several days, commonly practised in handling other classes of citrus, should be dispensed with or very greatly curtailed where limes are concerned: on the contrary, expeditious packing of fruit should be the rule, particularly during hot dry weather.

Fruit should also be protected from excessive desiccation by the use of water-proof cellophane or suitably waxed papers (6, 8).

The effect of passing fruit through the standard washing and grading machines is to cause an immediate loss in weight, while during the subsequent storage life desiccation also proceeds at a higher rate. Machine grading, is, of course essential, and the appearance of fruit is undoubtedly improved by washing and brushing. Where the storage period is to be brief there is no objection to fruit being passed through both the washing and grading machines : where a longer storage life is required, the mechanical injuries sustained in passing fruit through the machines, by increasing the rate of desiccation, may become of critical importance. In time suitable modifications may be introduced to lessen this source of depreciation.

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Pomelo or Shaddock.

The large size of the shaddock is unfavourable to its overseas transport and marketing. Experimental shipments from Palestine to England have been undertaken (1) ; although the fruit arrived in excellent condition, " It was considered that there would be great difficulty in creating a market for this fruit ". Other reports indicate that the oil and pectin of shaddocks may have commercial possibilities.

The shipping of pomeloes from Batavia, Java, to Holland—a voyage of five to six weeks—has been described by Spoon (2). When shipped at 2° to 4°C. (35.6° to 39.2°F.) there was practically no wastage, the fruit ripening well subsequently. The fruits, 6½ to 8½ in. in diameter, and weighing 2 to 3½ lb., were packed seven at a time in round crates of split bamboo, coconut fibre being used for packing,

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Cocoa (Cacao) Pods.

With the extension of research on cocoa (*Theobroma cacao*) problems, the need has arisen for transporting pods over long distances, the pods to be maintained in such condition that the seeds not only remain viable but are also capable of germinating and becoming established as seedlings. As a result of investigations in Trinidad (2) the following storage requirements have been ascertained.

Picking Maturity.

Pods should be picked just before they are fully ripe, as indicated by the change in colour, care being taken that all blemished or bruised pods are omitted from storage consignments.

Treatment and Packing.

A thin, uniform coat of vaseline should be smeared over the selected pods to curtail the excessive water-losses to which they are subject. Disinfectants, such as 2½ per cent. carbolic acid, or 0.2 per cent. mercuric chloride, reduce but do not entirely eliminate fungal rotting, certain organisms, present as latent infections, remaining unchecked by superficial treatments. The pods should be wrapped in grease-proof or cellophane paper and closely packed to avoid bruising. Even where superficial fungicidal treatments are applied a certain number of pods may be lost as a result of extensive rotting. This liability to fungal wastage and the variability in seed germination recorded (1, 2) make it imperative that individual samples should consist of not less than five to ten pods.

Storage Temperature.

A storage temperature of 60°-70°F. was found to be best suited to cacao pods, a high percentage of germination and of established seedlings being obtained from beans planted 40 days from the time of picking ; in some instances good seedlings were also obtained from beans planted 65 days from the time of picking (1).

At storage temperatures of 45° and 50°F., definite chill symptoms, in the form of abnormal pod and cotyledon colorations, were observed after 10 days. Beans held at 45°F. for 10 days showed no sign of germination, whereas those held at 50°F. gave 10 per cent. germination after 7 days but the seedlings died when the radicle had protruded a few mm. so that the effective germiation was nil. Pods held at these temperatures for longer periods became decidely discoloured, sometimes blackened, while the cotyledons of the beans were brown almost to the centre.

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Coconut.

Coconuts (*Cocos nucifera*) are stored at 32° to 35°F. and should keep from one to two months (1).

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Corn.

The quality for which sweet-corn is prized is chiefly due to its high sugar content. During development the amount of sugar increases gradually until the "milk-dough" stage is reached; thereafter there is a rapid decline in sweetness as the sugar is converted into starch. Appleman and Arthur (1) have shown that this process continues in storage, the rate of conversion of sugar to starch being about four times as rapid at 50°F. as at 32°F.; even at 32°F. more than 20 per cent. of the original sugar content disappears within four days, with concomitant loss of eating quality. These investigators also observed that the rate of loss of sugar declines with time, no further depletion taking place when the original sugar content had been depleted by 62 per cent.

From these observations it will be seen that the temperature to which sweet-corn is exposed after harvesting has a very marked influence on its quality, deterioration at high temperatures being very rapid (1, 4). At 86°F. approximately 50 per cent. of the original sugar content is lost in 24 hours, and there is a corresponding loss in flavour (3). If sweet-corn is to be stored it should be cooled immediately after harvesting (8) and held at 31° to 32°F. with a relative humidity of 90 to 95 per cent. Even at 32°F. much sugar is lost, but corn can be kept in saleable condition at this temperature one to four weeks, depending on its condition when stored (7). Quick cooling, by immersion in ice water and subsequent storage at 32°F., has been suggested (6, 8).

Brooks *et al.* (2) found that sweet corn showed no injury when treated to high concentrations of carbon dioxide during the initial cooling period, but during the holding period no beneficial results were observed. On the other hand Miller and Brooks (5) have reported that carbon dioxide treatment retards the loss of sugar in corn.

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CUCURBITS.

Members of the Cucurbitaceae have a wide distribution in warm-temperate, sub-tropical and tropical countries. Edible species include the cucumber (*Cucumis sativus*), the squash or pumpkin (*Cucurbita maxima*), cushaw and winter crook-neck squash (*Cucurbita moschata*), the vegetable marrow (*Cucurbita pepo*), the melons, musk-melons and cantaloupes (*Cucumis melo*), the watermelon (*Citrullus vulgaris*) and the christophine or cho-cho (*Sechium edule*).

Cucumber.

Few garden plants have been known to man longer than the cucumber, the plant, according to De Candolle, having been in cultivation for three to four thousand years.

Table cucumbers must be crisp and fresh when received by the consumer, and for preference should be of medium size, well-formed and of a dark-green colour over at least two-thirds of their length. Frequent gathering of fruits to prevent them from becoming too large or over-ripe, and prompt handling, are important. The fruits are usually packed into hampers in the field but in some districts there are centralised packing sheds where washing, machine grading, and packing are undertaken (1).

As more than 95 per cent. of the fresh weight of cucumbers consists of water, fruits are very subject to mechanical injury and to fungal and bacterial rotting; care in handling is therefore of great importance. Platenius *et al* (7) observed that small fruits were considerably more susceptible to disease injury than larger ones: in some instances, mature, fully grown fruits kept more than three times as long as immature ones of the same picking.

Corbett (2) makes an early reference to the transport of Texas-grown cucumbers to distant markets in standard refrigerator cars with bunker ice, the fruits being loaded into the car in bulk. The more modern practice as indicated above is to pack the fruits, after grading, into cases or hampers (1).

STORAGE TEMPERATURE.

It has been found that the keeping quality of cucumbers varies considerably from season to season and locality to locality, and accordingly

some difference of opinion has arisen as to the optimal storage temperature. Thus, Platenius *et al.* (7) found that at 32°F. or 40°F. American grown cucumbers can be held longer than at a higher temperature, whereas Rose *et al.* (9), who recommend a storage temperature of 50° to 60°F. state that if cucumbers are held at a temperature below 50°F., low temperature injury, in the form of dark coloured watery blemishes, makes its appearance. The watery areas in question are considered by Platenius *et al.* to be due tobacterial activity, their rate of development being greater at higher temperatures; breakdown, according to these workers was not apparent at 32° to 40°F. until after four to five weeks, and was always caused by disease infection. Other storage temperatures cited are : for German grown fruits, Plank and Schneider (6), 32°F. and R.H. of 85 per cent., with adequate ventilation, giving a storage life of three to four weeks, and Kochs (5) 36°F. and R.H. of 85 per cent. giving a storage life of three to four weeks with ozone supplied ; for American grown fruit, 45°F. and high R.H. (8).

In storage trials with tropically-grown cucumbers in Trinidad (10), green fruits of small, intermediate and large size were stored at 45°, 50° and 60°F. for periods up to 40 days. No difficulty was experienced in holding fruits in excellent condition at 45° and 50°F. for 20 to 25 days, the latter temperature being the more favourable. Thereafter the fruits, especially the more mature grade, began to show yellowing, accompanied by the production of a bitter flavour and the onset of fungal wastage. By the thirtieth day wastage was much in evidence at the several temperatures.

Humidity.

Cucumbers in storage lose moisture rapidly and tend to become unsightly through excessive shrivelling. Thus, with air-blast refrigeration, tropically-grown fruits held at 45°F. lost ten to 13 per cent. of their original weight, and those at 50°F. 11 to 15 per cent. in the course of 22 days, a relative humidity of 80 to 85 per cent. being maintained in the storage rooms (10). Platenius *et al.* (7) state that at 50° to 70°F. shrivelling is so rapid that fruits become unsaleable in the course of one to two weeks.

Hawthorn (3), working with Texas cucumbers during the warm dry season, has shown that the use of water-proof cellophane or waxed papers, by reducing the rate of moisture loss, materially increases the period during which fruits can be held at ordinary temperatures (84° to 88°F.). Quality tests, based on taste, indicate that fruits begin to lose their palatability after 20 days in storage, irrespective of their loss in weight. The storage period, however, can be considerably extended by refrigeration. Judged by appearance and palatability a loss of about ten per cent. of the original weight is critical. Where completely impermeable cellophane wrappers are used, condensation water tends to accumulate within the wrapper, fruits become slimy, and losses due to fungal rotting are accentuated (3, 7).

Fertilizer Treatment.

In studies of the effect of fertilizer treatments on yield, grade, flavour and keeping quality in storage, Kimbrough (4) states that keeping quality in storage was not noticeably affected.

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Pumpkin, Squash and Vegetable Marrow.

In general, pumpkins do not keep as long as the usual storage varieties of squash. Fruits of both classes should be mature and free from decay and mechanical injury when stored. At 55° to 60°F., with a relative humidity of 70 to 75 per cent., the best storage varieties of pumpkins should keep two to three months and squash three to six months (4). According to Cummings and Jenkins (1) squashes may be stored for long periods at 50° to 55°F. ; at higher temperatures the loss in weight tends to be excessive ; thus at 74°F., a loss of 63 per cent. of their weight in five months as against 20.1 per cent. in fruit held at 55°F. has been recorded. Mammoth cheese pumpkins are reported as having kept in good condition for 17 months. Discussing the storage of winter squash, Enzie (2) states that observations on some 30 varieties showed that the majority were not suited to long storage.

In a recent account of squash storage trials, Platenius *et al.* (3) state that most cold storage rooms are unsuitable for the storage of this commodity : the prevailing high humidities tend to promote fungal rotting, with concomitant breakdown of fruits within one to two months, regardless of the storage temperature adopted.

On the other hand at 60° to 70°F., with R.H. of less than 60 per cent., squash could be kept for more than five months. Under these conditions, however, losses due to shrinkage are very high, upwards of seven per cent. per month; in addition, an undesirably rapid conversion of starch to sugar takes place. They consider that suitable storage conditions are provided when the temperature is 40°F. and the R.H. below 70 per cent.: shrinkage is then less than three per cent. per month, the conversion of starch to sugar suitably slow, and a storage life of upwards of five months is assured. Attempts to effect an initial "curing" or hardening of the skin, as a means of reducing fungal wastage, were unsuccessful.

With reference to produce grown in the tropics, Smith (5) obtained favourable results with Jamaica grown English Green Bush vegetable marrow at temperatures from 36° to 52°F. The Long Green Jamaica Marrow-Squash proved unsatisfactory, and likewise the Boston Marrow, both being possessed of very tender skins. Other varieties of squashes, however, remained in good condition for several weeks at 42°F.

As a rule fruits are stored, three to four layers deep, on shelves in specially built houses providing the conditions of temperature and humidity described above.

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Cantaloupes and Melons.

The cantaloupe industry has been extensively developed in California, as many as 18,000 cars, each containing 336 crates of 68 lb. each, having been exported during a single season of approximately eight weeks (1). Muskmelons or cantaloupes, of which a considerable number of varieties is grown for marketing, should be handled rapidly and with care throughout all the operations of harvesting, grading, packing, loading and transport so as to minimise general deterioration and decay consequent on bruising (6).

The varieties preferred for marketing on a large scale are the smaller, nearly round, heavily netted kinds with green or salmon-coloured flesh. According to Beattie (2) this type has been selected for its carrying quality, its heavy protective netting and firm flesh, uniformity of size and shape, and for its superior quality when ripened on the vine. A secondary group of shipping melons includes the Casaba, Honeydew, and others of the semi-keeping or winter muskmelons (2).

Maturity, Chemical Composition and Quality.

A close relationship exists between maturity and sugar content (5), immature fruits being characterised by low sugar-content and poor flavour.

Distribution of Californian fruit to eastern markets in the United States may occupy ten to 20 days. Thus while fruit for local consumption may be picked when almost ripe on the vine, that for distant markets must be harvested before any trace of yellow colour has appeared and while the rind is still hard. Fruit picked too green not only lacks the full flavour and aroma on ripening, but tends to be shrivelled and tough after storage.

The relation between composition and commercial maturity has been studied by Chace, Church and Denny (4), with the following results: there is a direct correlation between the concentration of soluble solids in the juice and maturity, the percentage of sucrose, which increases during development, being a measure of maturity; also, the solids-content of the juice of good fruits is decidedly greater than in less desirable fruits; a definite correlation between maturity and refractive index of the juice has also been demonstrated, the index increasing with maturity; field-ripe fruits, *i.e.*, fully ripened on the vine, have a lower R.I. than "full-slip" fruits; their sucrose content and specific gravity are also lower. According to Chace, Church and Denny: "Great confidence may be placed in the correlation between refractive index and development. An immersion refractometer furnishes the most satisfactory means of placing a numerical value upon the extent to which melons have developed. The determination can be quickly made on small quantities of juice and small differences can be accurately measured." The starch content of the seeds during development and ripening is also a useful indicator, young seeds containing a demonstrable starch content, whereas those from mature fruits possess none at all, or only traces. Melons with less than 0.5 per cent. of starch in the seeds are considered to have reached a satisfactory state of maturity for harvesting.

Long periods of heavy rainfall or other unfavourable weather conditions make for fruit of poor quality; light rainfall during the ripening period favours the production of high quality fruit (5).

Picking Maturity.

It is desirable that melons should reach the greatest degree of maturity on the vines consistent with the storage life expected of them. The condition of the stem is important as a means of determining maturity. According to Rosa and Garthwaithe (13): "In most varieties, as ripening advances, a crack develops round the

stem where it joins the fruit. When maturation is complete, the stem slips cleanly from the fruit, which is then known as a 'full-slip'. No other guide is needed in picking fully ripened melons for the local market, though complications arise in packing melons at the proper stage for shipment".

In America, fruit is graded according to ripeness for long or short hauls. Difficulty may be experienced in knowing precisely when fruit should be picked, but in general, in "netted" varieties, the netting should be fully developed, well raised up, and rounded out on the surface. The netting of immature melons is flat and creased on the top, this crease filling up as the fruit ripens (6, 7). The dull-green background between the netting should also be developing a lighter shade. Where the shipping distance is short, melons may be left on the vine till they show a yellow tinge. The stems of fruits ready for harvesting should break easily a short distance from the melon. The highest quality, judged by palatability and aroma, is obtained when fruits are allowed to ripen on the vine. In varieties with pink flesh, picking maturity is still more difficult to assess, but by cutting open sample fruits the colour of seeds and flesh generally affords a good indication of maturity. If fruits are picked too green much of the desired flavour and bouquet may be lost.

For cantaloupes which have to be transported long distances, involving six to 12 days by rail, McKay, Fischer and Nelson (7) recommend that fruits should be picked just before the "full-slip" stage.

If Honeydew and Casaba melons are picked slightly unripe and exposed to ethylene (one part in 2000 of air) they show a marked acceleration of softening and colour change, though the total sugar content is not increased (12). Fruits picked very immature and artificially ripened by ethylene are of poor flavour, but with commercially mature fruit, a good eating quality is quickly obtained.

Wrapping and Crating.

In California, cantaloupes are picked as early in the morning as possible (1). For the large United States markets, a standard pack 12" by 12" by 22½", capable of holding 45 fruits, disposed in three layers, is regarded as most suitable (2). While the practice of wrapping fruit possesses obvious advantages, it is regarded as objectionable on the grounds that it makes for premature ripening (12, 13) and accentuates wastage, *i.e.*, by maintaining higher temperatures and humidities within the crates (8).

Loading, Precooling and Storage Temperatures.

Loading of crated fruit into refrigerator cars is effected as quickly as possible, the method of stowage adopted being such as to allow of uninterrupted and rapid air movement. Overholser and Moses (9) have described the rates of precooling of Californian cantaloupe packs in refrigerator cars. Where a long transport period is envisaged quick cooling is important. Rosa (12) found that warm fruits loaded into a pre-iced refrigerator car were not cooled to 40°F. until nearly three days. At this temperature ripening is delayed but not inhibited. McKay *et al.* (7) state that in well insulated cars, suitably equipped with floor-racks, and bunkered with ice and salt, a flesh temperature of approximately 40°F. can be obtained in the course of two days from loading, even when the air temperature at loading is high *e.g.* 95°F.; only 9.8 per cent. of the fruit was soft on the 11th day; in general, flesh temperatures varied from 33° to 40°F., according to position in the car. Chilling or other adverse effects were not recorded.

According to Chase *et al.* (4) refrigerator car temperatures of 33° to 40°F. did not injure melons during transport periods of ten days. When fruit was held in storage at 3°C. (37.4°F.) for periods up to 10 or 20 days, little change in chemical composition was observed but there was usually a decrease in sucrose on removal to a higher temperature. Urbina (14), discussing the transport of melons from Chili, considers that the optimum storage temperature lies in the neighbourhood of 32° to 34°F. Muskmelons grown in Trinidad, held at 45° and 50°F. for 15 to 20 days, were characterised by poor flavour and the development of anthracnose spots (15).

A general recommendation for American muskmelons is to the effect that fruits picked hard-ripe should keep one to three weeks at 35° to 40°F., but immature ones should not be stored at such a low temperature as they do not ripen properly; these should be stored at 50° to 55°F. when they will ripen slowly but will be in marketable condition after one to three weeks (11).

According to Platenius *et al.* (10) mature muskmelons may be kept at 32°F. for one month before the onset of moulds causes general breakdown.

Carbon Dioxide Treatment.

Carbon dioxide treatments, applied to muskmelons, Honeydew and Honeyball melons as an accessory means of preservation during cooling to the storage or transport temperature, have so far yielded inconclusive results. While it was difficult to determine the effect of the gas treatment upon quality and flavour, because of variability within the lots of fruit, a favourable effect on the maintenance of firmness and retarding of decay in muskmelons was observed (3).

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Watermelons.

The watermelon, native to Africa, is now widely distributed throughout the tropics. In the warmer regions of the United States it is cultivated on a commercial basis, certain States being known for their heavy production (1). A large number of types are known (6). A 32 to 34 lb. melon which loads 800 to 1000 to a car, is considered standard in the United States. Production may vary from 330 to 390 (average production) melons per acre, to 450 to 500 in good years (1).

The handling of watermelons on a commercial basis presents many difficulties, over-production and weather conditions during marketing being important. Varieties for marketing should be of uniform shape and size, and possess good flavour and keeping quality. Fruit for transport is liable to suffer from stem-end rot. This is minimised by retrimming the stem-end and treating the freshly cut surface with a disinfectant paste prior to loading (1). In the United States refrigerator cars are used for long overland haulage.

Chemical Composition, Maturity and Quality.

Whether sweetness in watermelons—a character regarded as of equal importance to yield—is a constant varietal character or a direct response to environment is not known. In California, only those varieties possessing noticeable sweetness are commercially important (5). The later stages of development and the onset of ripening in melons attached to the vines are characterised by a progressive increase in total solids, specific gravity of juice and sugar content; the flesh becomes sweeter and softer and the rind colour changes from green to yellow. Fruits picked immature and kept in storage at ordinary temperatures (70° to 75°F.) generally show a slight decrease in total sugar content, become softer, and if very immature, fail to acquire good flavour.

Kimbrough (3, 4) has investigated the effect of fertiliser treatment on the flavour and keeping quality of watermelons. In contrast to certain opinions commonly held (1, 2) his investigations showed that, on sandy soil, no apparent influence of fertiliser treatments, such as applications of nitrate of soda or potash, could be demonstrated either on the sugar content or on the keeping quality of fruit. The physiological disease known as "white heart" was likewise not attributable to fertiliser treatment; it is generally referred to unfavourable weather conditions during the fruiting period (8).

Storage Temperature.

Reporting on storage trials, Kimbrough (4) states that watermelons have been kept in storage at room temperature for as long as six weeks without rotting, but when cut the fruits were found to be uneatable. A consistent decrease in sugar content was characteristic of fruits thus stored.

When melons were stored at 35°, 40° and 50°F., it was found that the lower the temperature the better the fruits kept. After two months at 35°F., however, the fruits were in a bad internal condition, though externally they appeared sound. Kimbrough considers that for long storage a still lower temperature is required. Storage for one to three weeks at 35° to 40°F. has also been recorded (7).

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Christophine (*Sechium Edule*).

The christophine or cho-cho, an edible Cucurbit native to Jamaica and Cuba is frequently cultivated in West Indian gardens for use as a cooking vegetable. A knowledge of its cold storage requirements has still to be worked out in detail, but Smith (1) reports successful storage for three weeks at 45°F., the fruits being packed in tomato lugs with thin pads of wood wool under the covers. Green varieties proved more satisfactory than white ones as the latter developed a brown discoloration wherever the skin had been bruised.

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Dasheen.

The dasheen, taro or Chinese eddoe (*Colocasia esculenta*), a plant native to the East Indies (2) is now widely cultivated in tropical and subtropical regions (*e.g.*, the southern states of North America). According to Browne (1) dasheens intended for refrigerated storage should be handled carefully and held at 43° to 45°F., with a relative humidity of approximately 80 per cent., and free air circulation.

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Durian.

The durian, the fruit of an Eastern tree (*Durio zibethinus*), is "esteemed by those people who can overcome the strong odour and peculiar taste" (1). The flavour, described as "alliaceous and stercorary", is unlikely to find favour with the general public, while, for storage purposes, the strong smell of the fruit is liable to taint edible commodities in proximity.

In storage experiments with fruit consigned from Java to Holland in refrigerated chambers at 3°C. (37.4°F.) the smell was weak at the low temperature of transport but returned with full virulence on ripening at a higher temperature (2). The problem of exporting this fruit is also complicated by other factors, including its large size, the presence of a prickly exterior, the need for picking at a precise stage of maturity and the limited market.

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A LIST OF SOME PARASITES RECOVERED FROM ANIMALS AND POULTRY IN ANTIGUA, B.W.I.

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As far as the writer is aware, two reports so far have been published on animal parasites found in Antigua, one by Goodwin(1), and the other by Cameron (2). Neither author reported on any parasites from dogs or poultry.

Goodwin reported on the presence of both internal and external parasites only, while Cameron confines his study to internal parasites only, and covers the British West Indian Islands from Trinidad in the south to St. Kitts in the north, and Antigua is included in this collection. Unfortunately, for reference purposes he does not give the individual parasites from Antigua. Thus, in the list which follows where any specimen has not been recorded as being present by Goodwin, it is preceded by an asterisk. It will be noted that five specimens are so indicated.

The submitted list is by no means a complete one, but it is presented for the purpose of recording certain parasites which are present and have not been reported by the above workers.

The majority of these specimens were recovered from animals slaughtered at the Public Market where ample opportunities were available for the examination of several numbers and a fair knowledge as to the degree of infestation could be determined. Such conditions did not apply to equines, dogs and poultry and those obtained were from post mortem examinations.

I am indebted to Dr. Cameron, Director, Institute of Parasitology, Macdonald College, Canada, for having identified the specimens.

Equines.

External.

**Gastrophilus haemorrhoidalis*.—The larval form of the above was recovered from both donkeys and mules, being present in large numbers.

Internal.

Donkey.
1. *Strongylus equinus.*
2. *Strongylus vulgaris.*
3. *Setaria equina.*
4. *Triodentophorus* sp.
5. **Trichonema* spp.

Mule.
1. *Habronema microstoma.*
2. *Strongylus equinus.*
3. *Strongylus edentatus.*
4. *Trichonema* spp.

Horse.
1. *Ascaris equi.*
2. *Oxyuris equi.*

Cattle.

1. *Haemonchus contortus.*—Fairly heavy.
2. *Setaria labiato-papillosa.*—Rare.
3. *Ascaris vitulorum.*—Very heavy in young calves.

Sheep.

EXTERNAL.

1. *Oestrus ovis.*—The larval form is commonly found in the frontal sinuses of sheep.

INTERNAL.

1. **Monodontus trigonocephalus.*—Fairly common.
2. *Haemonchus contortus.*—Very heavy.
3. *Oesophagostomum columbianum.*—Fairly heavy.
4. *Dictyocaulus filaria.*—Fairly heavy.
5. *Cysticercus tenuicollis.*—Fairly heavy.

Goats.

1. **Trichiuris ovis.*—Rare.
2. *Haemonchus contortus.*—Very heavy.
3. *Dictyocaulus filaria.*—Fairly heavy.
4. *Moniezia expansa.*—Rare.

Pigs.

1. *Metastrongylus elongatus.*—Fairly heavy.
2. *Oesophagostomum dentatum.*—Rare.
3. **Hyostrongylus rubidus.*—Fairly heavy.
4. *Stephanuris dentatus.*—Exceedingly heavy.
5. *Cysticercus tenuicollis.*—Fairly heavy.

Dogs.

1. *Ancylostoma caninum.*
2. *Belascaris marginata.*
3. *Dipylidium caninum.*

Poultry.

1. *Ascaridia galli.*
2. *Raillietina tetragona.*

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A NOTE ON THE DEVELOPMENT OF THE ROOT SYSTEM OF BUDDED LIMES AFTER TRANSPLANTATION IN ST. LUCIA.

The budding of lime on sour orange stock is widely practised in the West Indies, and among the advantages claimed for this method is that of providing a deep tap-root for the limes, which, when grown from seedlings, develop only a system of surface roots. During a recent investigation in St. Lucia a number of roots were examined by the writer, the material being composed of seedling sour-orange growing in the nursery, budded lime three years old, after transplantation, and budded lime five years old growing in the field, and it was found that in the great majority of cases the tap-root does not develop after transplantation. The chief causes appear to be early damage by Citrus Weevil (*Diaprepes* spp.), and injury at transplantation. It would be of interest to know how far this condition is reproduced in other islands which suffer from damage to citrus caused by the larvae of *Diaprepes*.

In the case of the nursery stock all the plants uprooted (10) had a strongly growing tap-root and one or two laterals. When the budded plant is sent out from the nursery, for convenience in transport and planting, the tap-root is cut back until, on a plant 3 feet high above ground, it is about 1 foot 6 inches long, and the whole root system is packed in a ball of soil. Examination of material which had been transplanted gave the following results :—

Three year old plants, transplanted into pots 1 foot 8 inches high.

No. of plants.	Transplanted.	Examined.	No. of trees with tap root—living/dead.		No. of trees with root system mainly horizontal.
14	July, 1936	Jan., 1937	1	13	14
10	Sept., 1936	Jan., 1937	2	8	10

It is to be noted that the end of the cut tap-root did not reach the bottom of the container.

Five year old plants in the field (Reunion lime No. 6 budded on sour orange).

No. of plants examined.	Transplanted.	Examined.	No. of trees with tap root—living/dead.		No. of trees with root system mainly horizontal.
110	March, 1932	Jan., 1937	3	107	110

In the case of the three year old material the three plants with living tap-roots were abnormally developed. In one case the tap-root was twisted and distorted, and, though living, had only a few thin roots projecting from its sides. The terminal point was dead. In another case four roots grew downwards, approximately parallel. In the third case four rootlets sprang from the lowest point of the single root. Of the plants examined in the field one had a set of large roots growing downwards, another had seven roots branching from the main root apically, and the remaining one appeared to be normally developed.

Where the tap-roots were dead the basal portion had either disappeared, leaving exposed heart-wood, or was present in a rotten condition, and in some cases was of relatively considerable girth, indicating that growth of the base had continued for some time after transplantation.

The cause of death may have been injury by root-feeding insects, but this was certainly not the case with all the young material, of which about half had a dead tap-root, but showed no sign of insect injury. In all cases a thick mat of rootlets had developed from several major roots radiating almost at right angles to the axis of the trunk at a distance of an inch or two below the surface of the soil.

R. G. F.

WEST INDIAN NOTES.

(Compiled by the Advisory Department, Imperial College of Tropical Agriculture.)

The Sugar Industry.

The estimate of production given in these notes for the month of April remains unchanged and the harvesting of the 1937 crop is proceeding satisfactorily. Weather conditions have been generally favourable.

The announcement of an international agreement for the restriction of the export of sugar with the objects of raising and maintaining a more economic price level removes the element of uncertainty which has been hanging over the industry for a number of years. The continuance of the ordinary and certificated preferences in the United Kingdom on West Indian sugar is now guaranteed for a period of five years. On the other hand, the policy of controlled production with a reduced quota is unpopular in the West Indian area where during the past ten years expansion has been the order of the day. These colonies are fortunate in that the agreement was reached in 1937 and not five or ten years earlier when production was on a much lower level as may be seen from the following table of exports :—

	Average 3 years. 1926-1928	1932	1936
Antigua	17,234	18,448	19,859
Barbados	53,850	100,000	119,685
British Guiana	102,998	137,078	176,500
Jamaica	47,516	38,488	77,733
St. Kitts	17,234	19,327	26,141
St. Lucia	4,636	4,990	7,706
St. Vincent	434	200	500
Trinidad	60,532	85,956	142,671
Total	304,434	404,487	570,795

The sugar interests in each Colony will have to devote a great deal of thought to the new situation brought about by the signing of the agreement. This is especially the case where canes are produced by a large number of small producers as is the case in Trinidad and to a lesser extent in most other Colonies. It will probably involve the institution of a scheme for the registration of growers and then the allocation of a certain tonnage to each individual. When it is realised that in Trinidad alone there are some 19,500 individuals supplying canes to the various factories the complexity of the problem becomes obvious.

Where the unit of production is larger and is in the hands of planters or companies the problems to be faced are of a different nature. These will involve a careful study of the most economical areas to be planted paying due regard to the most suitable varieties, cultural methods, manurial treatment and transport costs. Those estates which have in the past kept accurate cost accounts will be in a favourable position to take advantage of the changed conditions.

It is obvious that the need for continued research will be as pressingly felt as at any other time in the history of the industry. With a restricted production the need for reducing costs by eliminating wasteful practices and adopting every tried improved method which agricultural science has to offer becomes evident.

Syrup Production.

During the past two seasons the production and marketing of fancy molasses in Barbados have been much discussed. Legislation has been enacted limiting the exportation to a certain fixed quantity and fixing the price to be paid for locally produced syrup. There is some danger that this effort will tend to stimulate increased production in other Colonies where syrup is now manufactured in fluctuating quantities thus embarassing the Barbados attempt at orderly marketing. It would be to the advantage of all Colonies to work together in this as in other marketing problems.

A recent report on a visit to St. Vincent by the Sugar Technologist at the College to consult with the crop specialist who is engaged in efforts to improve the quality of locally produced syrup, discloses the fact that the quality of St. Vincent syrup produced by most of the estates is quite up to the Barbados standard. Proposals are now under consideration for the blending, prior to export, of all syrup produced by the improved method under the direction of the crop specialist.

There is a promising improved demand for this better class product and the exports of syrup from St. Vincent during 1937 show an increase over exports in previous years.

New Sugar Cane Varieties.

B. 2935 is one of the newer varieties which is becoming a favourite when grown in light soils under medium and low rainfall conditions. Its performance this season in St. Kitts will justify its being planted on areas previously occupied by Sc. 12/4. The Central Cane Breeding Station in Barbados have recommended other varieties for extensive trials and these varieties are being multiplied by a quick method described in a Bulletin recently published by this Station.

The Sea Island Cotton Industry.

The West Indian Sea Island Cotton Association reports that the production of those Islands planting in the fall of 1936 and reaped during the first five months of the year has fallen short of the last published estimate given in *Tropical Agriculture* for April. This is due to unfavourable weather conditions and to severe attacks by insect pests.

Montserrat and St. Kitts whose planting season is February to April report that heavy sowings have been made, that the germination was good and that provided suitable weather conditions

prevail a production of 3,000 to 3,500 bales of 400 lb. each may be expected. At the end of May there was need for rain.

Arrangements have been made by the Advisory Committee in England to cable reliable market information fortnightly to the Secretary of the West Indian Association who has arranged with the Canadian Press to have the information published in each Island.

The most recent of these reports indicate that the supplies are short and that prices range between 20 and 24 pence per lb.

The Secretary to the Advisory Committee has received folders from the manufacturers of "Chilprufe" garments illustrating a very wide range of ladies and children's underwear made from Sea Island Cotton. This is a new and important development.

Reports by Mr. F. A. Squire, Cotton Pest Entomologist, point to satisfactory progress being made in the study of insect pests of cotton under West Indian conditions. Mr. Squire emphasises the need for the most strict application of the close season regulations and especially the destruction of all cotton seed and seed cotton not required for planting purposes and which may be in the hands of growers after the close season period. Such material has been shown to be the starting point for severe outbreaks of pink bollworm later in the season. The entomologist also points out the importance of the early destruction of cotton bushes once the main crop is over and he strongly advocates a close season of not less than 3½ months duration. In several of the islands the close season extends for only two months.

The Lime Industry.

Lime oil export figures for 1932 to 1936 are reproduced below. They are taken from the Report of the Second Meeting of the British West Indies Fruit and Vegetable Council (Eastern Group).

During the first four months of this year the demand for distilled lime oil was particularly good and the West Indian Lime Oil Sales Company disposed of most of its holdings. The difficulty of disposing of the last few thousand pounds of this oil indicates the very limited market that exists for the product and the grave risk involved in extending the cultivation of limes unduly.

Figures are given below of the exports of fresh or green limes during the past three years.

Table I.—Export Figures for Distilled Lime Oil 1932-1936.

(*a*) *In the West Indies and British Guiana.*

Place.	1932.	1933.	1934.	1935.	1936.
	lb.	lb.	lb.	lb.	lb.
* Dominica	11,218	9,302	6,288	7,127	9,189
† St. Lucia	9,766	7,161	13,406	10,264	5,463
† Grenada	6,400	3,799	6,171	8,840	6,077
† Trinidad	6,715	15,487	24,055	14,751	22,016
* Antigua	952	680	340	476	2,108
* Montserrat	280	—	1,245	416	348
* British Guiana	6,205	9,911	7,582	5,074	6,222
† Jamaica	3,357	5,066	969	4,063	3,527
Total	44,893	51,406	60,056	51,011	54,950

* Annual Report of Agricultural Department. 8.5 lb. = 1 gal.
† Blue Books.

Table II.—Exports of Green Limes (In barrels) 1934-1936.

Island.	1934.				1935.				1936.			
	U.S.A.	Canada.	Bermuda U.K. and B.W.I.	Total.	U.S.A.	Canada.	Bermuda U.K. and B.W.I.	Total	U.S.A.	Canada.	Bermuda U.K. and B.W.I.	Total.
Dominica	3,659	89	42	3,790	3,782	140	113	4,035	2,633	548	374	3,555
St. Lucia	4,945	261	794*	6,000	5,112	453	1,054*	6,619	4,093	573	1,065*	5,731
Montserrat	3,246	344	58	3,648	1,711	362	44	2,117	515	356	25	896
Trinidad....	909	529	1	1,439	371	—	194	565	970	101	320	1,391
Grenada	—	—	—	1,027	—	—	—	418	—	—	—	150
Total	12,759	1,223	895	15,904	10,976	955	1,405	13,754	8,211	1,578	1,784	11,723

* This figure includes 55, 131 and 114 barrels in 1934, 1935 and 1936 respectively to the United Kingdom.

Table III.—Exports of Bananas from the Colonies in the Eastern Group to the Canadian Banana Company during 1935 and 1936.

	Trinidad.		Grenada.		St. Vincent*.		St. Lucia.		Dominica.		Total.	
	1935.	1936.	1935.	1936.	1935.	1936.	1935.	1936.	1935.	1936.	1935.	1936.
Nines	23,549	55,033	19,723	48,328	1,286	6,190	17,067	27,230	19,677	27,852	81,302	164,633
Eights	20,672	49,832	15,222	42,868	1,648	10,180	18,596	31,912	21,110	29,448	77,248	164,240
Sevens	21,868	53,844	16,747	51,736	2,436	14,754	20,166	40,036	22,954	34,270	84,171	194,640
Sixes	280	376	4,760	12,636	400	3,036	4,064	8,868	2,051	1,952	11,555	26,868
Total Stems	66,369	159,085	56,452	155,568	5,770	34,160	59,893	108,046	65,792	93,522	254,276	550,381
Equivalent Counts	50,053	119,423	40,703	109,506	3,840	21,961	42,113	73,508	47,496	67,556	184,205	391,954
Percentage Counts	75%	75%	72%	70%	66%	64%	70%	68%	72%	72%	72%	71%

* First shipment in July, 1935.

The possibility of further developing the green lime market in the United States of America, Great Britain and Canada was fully considered at the meeting of the Fruit Council. It is a matter of considerable importance in view of the immediate prospect of increased production and the limited demand for distilled oil referred to above.

The Banana Industry.

The Canadian Banana Company recently offered an increase in price for nine and eight hand bunches conditional on the contract being renewed for a further period of five years, *i.e.*, until 1944. The island banana associations unanimously agreed to ask the Company to pay for bananas on a sliding scale system of payment dependent on the market value of bananas in the United Kingdom. Information is now to hand that the Company finds itself unable to agree to this method of payment and renews its former offer. The associations have now reluctantly accepted the price offered and have agreed to a renewal of the contract for five years. The development which has taken place in this industry is indicated by the (Table III) exports for 1935 and 1936.

In St. Vincent during January and February, 1937 considerable quantities of fruit had to be rejected on account of its being affected with numerous small black spots. The spotting was found to be due to a species of thrips, *Frankliniella insularis*, which laid its eggs in the very young fruit. The thrips normally inhabit the flowers of leguminous plants and the removal of *Canavalia ensiformis* (Sword beans) which were planted as a cover crop among the bananas in one area was immediately accompanied by a reduction in the amount of spotting. At the present time the amount of spotting is negligible and is insufficient to cause the rejection of fruit.

Entomological Work.

Lixophaga Campaign.

An account of the *Lixophaga* campaign for 1936 is given by Mr. Box in his recent report,* from which the following information has been taken.

Surveys conducted in 1935 and 1936 gave evidence that the population of *Lixophaga* was declining, and it was found that cane infestation during the 1936 crop had risen to the normal figure of 12.1 per cent. joint infestation, as compared with 5.0 per cent. in 1934. In view of the satisfactory control obtained in 1934, "it was decided to initiate the further breeding and distribution of *Lixophaga* in 1936, and, if necessary, to continue the work as a regular part of factory routine". In addition it was urged that an attempt be made to ascertain the causes of the initial failure of the fly to become established.

A new breeding campaign was begun with 211 puparia brought from St. Kitts, and from this stock 17,300 parasites were reared between June

* Sugar-Cane Moth Borer (*Diatraea*) Investigations No. 3, Report on *Lixophaga* campaign for 1936 and the Status of the Parasite in Antigua at the end of the year, by H. E. Box, F.R.E.S.

and November, and 6,115 fertile females were distributed to estates. Two hundred and sixty-eight colonies were liberated, with 22 to 23 fertile females per colony. The campaign was terminated at the end of October, though stocks are being maintained in the laboratory in readiness for further large-scale breeding in 1937.

On the return of Mr. Box to Antigua in October a survey to determine the status of *Lixophaga* was decided upon, and was commenced on 10th November. In the following seven weeks practically every estate where flies had been released was examined. The results of the survey (given in detail in the report) are briefly summarised in the following table in which comparison is made with earlier figures.

Months of Survey.	1933 vi-vii.	1934 v-vi.	1935 vi-vii.	1936 xi-xii.
No. of fields examined	80	79	168	238
No. of infested canes examined	4,999	4,423	9,631	27,180
Total *Diatraea* stages	3,047	3,224	5,305	12,950
Per cent. parasitism by *Lixophaga* :				
(*a*) In "positive" fields only :				
current	2.2%	5.3%	2.4%	8.01%
No. of fields	2	9	6	49
Total	1.1%	4.5%	3.2%	5.19%
No. of fields	6	12	8	70
(*b*) In all fields examined :				
current	0.12%	1.0%	0.34%	1.95%
Total	0.2 %	1.1%	0.43%	1.81%

(By *current parasitism* is understood the parasitism among living *Diatraea* stages only; *total parasitism* includes the residual stages, *i.e.*, "emerged" pupae of *Diatraea* and puparia of *Lixophaga*. The proportion of one percentage to the other is a useful, if rough, guide to the progress of parasitism in each area.)

In the discussion of results, the Report states: "The status of *Lixophaga* in Antigua at the end of 1936 was incomparably better than at any previous time since its introduction from Cuba in April, 1932. More and better colonies are established in the fields, and over a much wider territory than in any other year . . . It is not possible to state with exactitude the reasons for these better results, because many independent and interacting factors are involved, and these are far from being fully understood." It has been established that, if the flies are about to succeed in any field, they will do so from one or two colonies of 20 to 25 fertile females, and also that flies should not be liberated in ratoon fields unless the ratoons at the time are heavily infested with larvae of *Diatraea*. Parasitism of *Diatraea* by a fungus, *Cordyceps barberi* Giard, was found to average 18.34 per cent., though the mean annual percentage is considered to be rather less than this.

Research on Cotton Pests.

In a Report on Work during the half-year September, 1936 to February, 1937, Mr. F. A. Squire summarises his findings with regard to Pink Bollworm and Cotton stainers.

The Pink Bollworm.

The life history of the Pink Bollworm is being studied in detail, and an attempt is being made to determine the factors responsible for inducing the "resting stage" which is entered upon by certain larvae. From his observations in the West Indies, Mr. Squire concludes that this resting stage, or diapause, is not a seasonal phenomenon, and states that a large percentage of larvae go into diapause towards the end of the season, and obtained evidence indicating that the diapause may be correlated with the stage of dryness of the food.

An interesting point which has recently come to light is that flowers infested with larvae present a characteristic appearance in that the petals expand but the tips remain joined and unfurled. This allows ready determination of the presence of the insect to be made, so that its presence, even in small numbers, can be noted. It may prove of practical value in forecasting outbreaks.

Some recorded alternative hosts have been examined, and of them *Hibiscus sabdariffa* is regarded as being of negligible importance. Infestation of ochroe (*H. esculentus*) has been noted, but it seems to rise only as the supply of primary host becomes insufficient. It is doubted whether this plant is of importance in permitting the larvae to bridge the close season. The chief factors responsible appear to be laxity in observing close season regulations, the retention of seed and seed cotton by certain growers, and inter-island trade in these commodities. An examination was made of fields in certain islands to determine whether larvae survive the close season in the soil, or in dropped bolls, and such evidence as was obtained suggests that such survival is unlikely.

Cotton Stainers.

The life history of the two species involved, *Dysdercus delauneyi* Leth. and *D. andreae* L. has been studied, and attention is being focussed on the sequence of food plants during the year. At present there are indications that the cotton crop forms part of a chain of available food material of which *Sterculia caribaea* (Mountain Mahoe) and *Ochroma lagopus* (Bois Flot) are important members fruiting at different times of the year, but overlapping the cotton crop at each end.

Citrus Weevil Investigation.

As a result of the findings of the preliminary experiments laid down in 1936, of which some account has already appeared in these notes, a visit was paid to St. Lucia in March by Mr. R. G. Fennah to lay down an experiment at Union Experiment Station designed to provide data from which the efficiency of two treatments,

which have been proved to have a significantly depressing effect on larval infestation, may be assessed. Protective layers of bagasse treated with asphaltic road oil, and of a dressing of acid lead arsenate, applied to the surface of the soil below the canopy, are being tested against a control, while, on the cultural side, inarching is being tested as a means of accelerating recovery of damaged trees. Quantitive determinations will be made of yield and quality of fruit, and growth of the trees.

As Mr. Fennah has recently been seconded to carry out the investigation for three years, he intends at the close of the academic year to transfer his headquarters to St. Lucia during the ovipositing period of the weevil in that island.

Brevities.

Mr. C. C. Skeete proceeded on 5½ months leave of absence leaving Trinidad on 26th April.

* * *

Mr. Fennah proceeded to St. Lucia on 22nd June and will in due course visit Dominica and Montserrat.

* * *

The Commissioner of Agriculture left Trinidad on 22nd June for an extended tour of St. Lucia and the Leeward Islands.

* * *

Mr. C. T. Watts, College Engineer, visited Montserrat on his way from Bermuda and reported on the condition of the Cold Storage plant in that Island.

* * *

Mr. R. G. Fennah has been seconded from the service of the College and has been appointed Citrus Pest Entomologist as from 1st April, 1937, for a period of three years.

The Cotton Pest Entomologist changed his headquarters from St. Vincent to Montserrat on 9th June. Mr. Squire will visit several cotton growing Islands during the next three months.

* * *

Mr. J. G. Davies, Sugar Technologist, recently paid a visit to St. Vincent to report on the progress of the work of improving the quality of the fancy molasses manufactured in that Island.

* * *

The Assistant Commissioner of Agriculture made a tour of the Leeward Islands leaving Trinidad on 15th March and returning on 21st April. During this period he visited Antigua, St. Kitts, Nevis, Montserrat and the Virgin Islands.

* * *

Mr. J. B. Hutchinson has been appointed Geneticist at the Cotton Research Station, Trinidad, succeeding Dr. Harland. Mr. Hutchinson who arrived in Trinidad on 5th June has also been appointed Cotton Adviser to the Commissioner of Agriculture.

REVIEWS.

THE TROPICAL GARDEN.

By Loraine E. Kuck and Richard C. Tongg. Pages x+378. 16 plates. *The Macmillan Co.*, New York, 1936. Price 12*s*. 6*d*.

This book is a most welcome addition to the literature on gardening in the tropics. Other books hitherto published on tropical gardening, although of general interest in many respects, have special reference to Ceylon and Malaya, East Africa and the West Indies. The book now under review is therefore all the more welcome because the descriptions made and the suggestions put forward in it are based upon plants and conditions existing in another part of the tropics, namely in the Hawaiian Islands.

The authors state that " It is the aim of this book to cover the subject of garden making in the tropics from two angles: design, which is its art and philosophy; and the choice of plants and their culture, which is its science ". The task which the authors set themselves has been well accomplished.

The first six chapters deal with the design of tropical gardens and describe the conditions in, and requirements of particular situations or environments, such as " dry gardens and patios ", " water and rock gardens ", " beach and mountain gardens ". Such aspects of tropical gardening have provided ample scope for the fertile imaginations of the authors. Their recommendations, which are likely to find best application in the planning and lay-out of public parks and large gardens, have their limitations, however, as so much must depend upon the site and size of the garden, its soil and climatic conditions and, not the least, upon the individual preferences of the designer. Nevertheless those responsible for breaking new land for the establishment of a garden or remodelling an old garden would do well to take note of the ideas expressed in this book.

The remaining chapters contain descriptions of a very wide range of tropical ornamental plants, including trees, shrubs, creepers, and herbaceous plants with useful information as to their culture and suitability to particular conditions. Gardeners in the West Indies, and no doubt in other parts of the tropics, will learn of the existence of many beautiful plants which are not now found in their regions. Conversely, no mention is made of certain plants existing and regarded as highly ornamental in the West Indies. The opportunity is now offered for exchange.

The authors do not claim rigid botanical accuracy in their descriptions of plants, and it is questionable whether many of the plants have been given their correct specific names. It is evident, for instance, that the description given to *Cassia nodosa* belongs in reality to *Cassia javanica*, and no reference is made to the former which is possibly even more beautiful than the latter. Trees have been classified as "large" trees and "small" trees: it would also have been advantageous if a distinction had been drawn between ornamental flowering trees and ornamental foliage trees. The suitability of certain trees for particular purposes must also be questioned. For instance (on page 100) *Ficus Benjamina* is mentioned as a suitable tree for street planting, but from experience in the West Indies it would be classified as highly unsuitable owing to its very low branching habit and the ability of its roots to cause cracks in concrete pavements and walls. Also, not many fruit trees, except perhaps *Chrysophyllum Cainito*, the star apple, would be classed as "ornamental"; but an entire chapter is allocated to the description of tropical fruits as "ornamentals". Several notable omissions are observed in the chapter on "Evergreens in the tropics", particularly such trees as *Ficus nitida* and *Ficus Benjamina*, *Capparis cynophallophora*, *Pimenta acris*, and among the Cassias, *C. Siamea*. There are also many evergreen shrubs not mentioned, perhaps one of the best of which is *Triphasia trifolia*.

Four long chapters are devoted to a very comprehensive account of tropical shrubs and creepers from which it will be realized what a wealth of beautiful plants the Hawaiian Islands possess. Yet there are some important species omitted which are known in the West Indies. A chapter is devoted to the description of a collection of plants which are classed as "Exotics". Here, as in many other instances in the book the word "exotic" is used in a botanically incorrect sense, which is unfortunately misleading. The authors use the term *exotic* "in an artistic sense as of strange in appearance compared to the more typical plants of the temperate zone". Some of the plants included in this group are Alocasias and related plants, Begonias, Anthuriums, plants of the banana family, Dracaenas, Bamboos and other large grasses. The fact seems to have been overlooked that these plants are not "strange in appearance" to people living in the tropics.

A chapter is devoted to "tropical horticulture", with special reference to Hawaii. While no attempt can be made to criticise the authors' recommendations in respect of their application to soil and climatic conditions of the Hawaiian Islands, it is important that gardeners in other parts of the tropics should realise that their soils may be very different from those in the Hawaiian Islands and their requirements may likewise be very different. It is a dangerous and possibly wasteful policy to assume that the soils of any particular region can be "handled exactly like those of any other locality", and that "general treatises on soil management are applicable". Gardeners would be well advised to apply to the soil scientists of their particular country or district for directions as to the correct management of their soils.

In the concluding chapter a useful classification of plants is made according to the colour of their most ornamental parts, whether it be foliage, flower or fruit, and to the time of the year, under Hawaiian conditions, when their ornamental characters are most evident.

A chapter on the culture of vegetables would have been a useful addition to the book, especially now that, as the result of work in recent years, excellent varieties of northern vegetables, such as the cauliflower, can be successfully grown in the tropics.

The book is well printed and contains 16 plates on each of which three clear photographs of garden scenery or collections of garden plants are reproduced. All gardeners in the tropics are recommended to add this book to their collection of literature on tropical gardening.

C. C. S.

* * *

CENTRAL AGRICULTURAL AND SCIENTIFIC BIBLIOGRAPHY.

Modern mass-production of scientific and technical literature led first to the growth of comprehensive abstract services, which, as literary proliferation increased, have tended to bury the references to articles on specific subjects in the mass of abstracts on all subjects. Thus has developed the present-day demand for specialised bibliographies—lists of references classified according to the titles of the articles noticed, and informing about the quantity rather than the quality of scientific literature. A comprehensive bibliography on all branches of agriculture and allied subjects is now being organised at the Science Library, South Kensington, London S.W.7. As the Library takes most of the four thousand or so agricultural journals published throughout the world, it offers unusually good facilities for the preparation of such a bibliography. Subscribers, paying 10*s*. per annum as individuals or £5 5*s*. as institutions, will have full access to the bibliography and special facilities for reference to books in the Library. Translations and abstracts will also be made. The service commenced on 1st March, 1936. (*Nature*, Vol. CXXXVII, No. 3464, p. 489.)

THE subscription to *Tropical Agriculture* is six shillings per annum, post free, Trinidad currency, to all countries within the British Empire or seven shillings and six pence, post free, Trinidad currency, to all other countries. Subscriptions can commence at any time during the year.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Comparative Hardness of Tasselled *vs.* Untasselled Canes—*C. E. Pemberton.*

Use was made of an instrument, similar to one previously reported from India, for measuring the hardness of sugar canes. In these measurements it was noticed that tasselled canes were invariably softer than untasselled canes. This relation is evident from the following tabulation of the measured hardness of Hawaiian seedling canes in comparison with POJ 2878 :—

Variety.	Tasselled.	Un-tasselled.	Ratio.
POJ 2878	4.9	10.6	2.16
31-3040	7.5	14.5	1.93
32-177	7.9	13.9	1.76
31-3012	6.2	12.3	1.98
29-2196	6.9	15.1	2.18
32-1577	6.9	16.3	2.36
32-1594	8.7	17.0	1.95
32-1756	5.9	10.3	1.74
27-8101	3.9	8.4	2.15

In all these tests the tasselled and untasselled canes were growing in the same field and were approximately of the same age. It will be noted that the tasselled canes may be 2 to 2½ times as hard as the untasselled. Varieties that *lala* profusely are not as soft as varieties that *lala* very weakly.

The fact that canes which have tasselled are definitely softer than those which have not tasselled may explain the greater incidence of borer infestation in localities where some varieties tassel very heavily. Independently of tasselling, some varieties are softer than others (compare 32-1756 and 27-8101 in the table). This also has a bearing on the relative susceptibility to borer infestation.—(*Int. Sugar Jr.*, Vol. XXXIX, No. 461, p. 189, 1937.)

* * *

Transporting Molasses in Bulk in Tankers. *By B. Orchard Lisle.*

There are several reasons why it is not always desirable to employ ordinary oil tankers in the molassses trade, one of which is the spoiling of the cargo by contamination with the previous product shipped, which may have been crude petroleum oil or even creosote. But the main reason concerns the danger of the ship. Cane molasses has a density of 1.35 to 1.45, and oil one around 0.85 to 0.95, which means that the deadweight carried with a cargo of molasses will occupy a considerably smaller space than with oil, resulting in slack tanks, and possibly causing the severe straining of bulkheads.

Among the designs introduced for special molasses tankers is one incorporating a double bottom under the tanks so that the centre of gravity is higher than would otherwise be the case, and the load is distributed more evenly. When designed specially, the cylindrical-tank type of vessel has definite advantages. In the first place, the load is distributed evenly and the centre of gravity is raised.

Cylindrical shape lends itself to rigid construction and, should it be found desirable for purposes of trim to have any of the tanks slack, the surge of the liquid resolves into a sort of swirling motion considerably less harmful than the rush from side to side which takes place in normally shaped tanks. Probably the best, and certainly the most modern, design is that of alternating long tanks holding about 1,500 tons with shorter tanks holding about 750 tons each, the former being used only for molasses and the latter for water ballast.

Tank ships designed for molasses carriage must be very strongly constructed, with heavy bottom and lower shell plating, because of the contracted weight. Such vessels are known to sag as much as six inches in the middle, and therefore need the additional strength to withstand such strain. Bulkheads, also, must be strong, so as not to buckle when a full tank is adjacent to an empty one, as when tanks are alternately long and short.

Opinion seems to vary as to the temperature at which molasses should be maintained for the most convenient pumping, but it is generally held that 90°F. (about 32°C.) will serve the purpose. Sometimes shippers refuse to permit the heating of the cargo, but where this is allowed good pumping results are achieved at 150°F. (66°C.). If live steam be used for heating the possibility of local superheating must be avoided, otherwise the molasses "candies". Flexible hoses must be armoured for extra strength.—(*Int. Sugar Jr.*, Vol. XXXIX, No. 460, p. 158, 1937).

ACIDITY AND WASTE.

Tests conducted last year in conjunction with the Department of Scientific and Industrial Research, U.K., showed that the incidence of mould development in export navel oranges after arrival in the United Kingdom bore no apparent relation to the degree of acidity, and, to some extent also, the thickness of the rind. High acidity and a thick rind were associated with a low wastage. Oranges having an acid percentage of 1.66 per cent. (equal to a 23.7 c.cms. test) and a rind percentage of 36 per cent. showed 1.3 per cent. of waste, whereas those with an acidity of 0.75 per cent. (10.7 c.cms.) and 27.5 per cent. rind had as much as 40 per cent. waste.—(*Hadar*, Vol. VIII, No. 12, p. 331, 1935.)

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

The Estimation of Vitamins.

The literature on the subject of the vitamins is so voluminous, and is dispersed through such a large number of periodicals, that any comprehensive survey of even one aspect of the question is a task of very great complexity. It was, therefore, an excellent idea that the recent opening meeting of the Food Group of the Society of Chemical Industry should be devoted to a number of papers reviewing the chemical and physical methods of estimating the vitamins. This particular aspect is of especial interest to the food manufacturer, since the biological methods of assay are both expensive and require a great length of time for their performance. The methods of estimating vitamin A are probably the most reliable, and the paper on this vitamin dealt with such well-known methods as the Vitameter and the spectrograph; the complex question of the treatment of substances containing vitamin A and carotene was also touched on. The formaldehyde azo reaction for vitamin B, and the indole reduction method for vitamin C were described in two very informative papers, and precise details of the necessary conditions were given. Lastly, the somewhat controversial methods of estimating vitamin D were described. The method of Brockman, using antimony trichloride, which gives a pink colour reaction, was described.—(*Food*, November, 1936, p. 43.)

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Food Value of Papaw.

Recent investigations at the Hawaii Agricultural Experiment Station, Honolulu, have been described in an article by Dr. C. D. Miller and Dr. R. C. Robbins, which appeared in the *Biochemical Journal*, Vol. XXI, No. 1, pp. 1-11. Data for the chemical analysis of the edible portion of the ripe fruit are therein presented; they include new facts concerning the mineral and vitamin contents and the acid-base value of the papaw fruit. Some average values are summarised in the following table:—

	Per cent. of fresh fruit.
Total acid (expressed as citric acid)	0.13
Protein	0.50
Ether extract (mainly fats)	0.30
Crude fibre	0.80
Carbohydrate (by difference)	12.30
Total ash	0.51
Calcium	0.019
Phosphorus	0.013
Iron	0.00025
Acid : base ratio	5.7 cc. N/1 alkali per gram.

From these figures it may be concluded that papaw compares favourably with oranges as a source of calcium and of basic ash. The determinations of vitamin contents by chemical methods and by feeding tests on guinea pigs and rats showed that papaw contains about the same amount of vitamin C (ascorbic acid) as oranges, as well as considerable amounts of vitamin A and vitamins B1 and B2.

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The Chemistry and Industrial Uses of Pectin.

There are three principal sources of pectin, namely: the pectin of fruits, which is directly soluble in water; acid pectin (pectic acid), which is obtained by hot extraction of beet pulp, and hydrated pectin, which is extracted from various vegetable tissues by heating or by some appropriate method of hydrolysis.

From the chemical standpoint, pectin is a source of araban and polygalacturonic acids; on decomposition it also yields methyl alcohol. The pectin of sugar beets contains up to 68 per cent. of galacturonic acid.

Pectin is used in numerous ways. At present, its most extensive use is in the manufacture of confectionery and jellies. It is used to some extent in medicine, especially in treating intestinal disorders of children. According to some recent work, it can be used to effect a complete separation of the serum of milk; when added to fresh milk in the proportion of about 0.6 per cent., the milk separates into two phases, of which one consists of water and the other is a concentrate resembling condensed milk. Other proposed uses of pectin are as a wood preservative and as a filler in cosmetics. — (H. Claassen; *Facts about Sugar*, Vol. XXXI, No. 12, p. 473, 1936.)

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Hormones and Horticulture.

A useful résumé of present-day knowledge of plant hormones, or growth-regulating substances is given by Dr. M. A. H. Tincker (*J. Roy. Hort. Soc.* **61**, Pt. 9; Sept. 1936). The history of investigations in this subject goes back to Darwin, and the work of Rothert and Fitting, of Boysen-Jensen, and later of Loeb and Went, established the idea of chemical 'messengers' or regulators, as a feature of plant physiology. Much of the earlier work dealt with the bending of coleoptiles of cereal seedlings, but the findings of Went, that a root-forming substance was produced by leaves, initiated a new line of horticultural inquiry. Later investigations showed that the growth-promoting substance was an organic acid. It was produced by a wide variety of plants, and was even found in such products as rice polishings, wheat-germ oil and pollen. The active substance is indolylacetic acid, and it can be synthesized *in vitro*. Perhaps the most valuable line of future horticultural work is that suggested by Hitchcock and Zimmerman, who have used root-producing hormones in the propagation of difficult cuttings, such as maple and apple.—(*Nature*, Vol. CXXXVIII, No. 3496, p. 766, 1936.)

TREND OF THE MARKETS.

[The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.)

	Foreign. s. d.	*Preferential.* s. d.
29th April	6 3¾	10 0¾
6th May	6 3¾	10 0¾
13th May	6 5¼	10 1½
20th May	6 6	10 0
27th May	6 6	10 3
3rd June	6 6	10 4½
10th June	6 6	10 4½
(11th June, 1936)	4 9	8 6

The most important event since our last report has been the signing of an agreement by the International Sugar Conference. By establishing basic export quotas in all participating countries it is hoped that this will not only maintain the free market but also extend it by promoting increased consumption. The agreement is to run for a period of five years to commence on 1st September next and to terminate on 31st August, 1942. It will be administered by a General Council known as the International Sugar Council. The British Colonies have been allotted a quota of 950,000 tons which will in no circumstances be scaled down. Favourable conference news has brought a fractional hardening in prices on the market but upward trends have in some measure been counteracted by continued weakness of the stock exchanges and heavy declines in the commodity markets. The general undertone is quite steady.

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COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association :—

	American Mid.	*Egyptian F.G.F. Sakel.*
30th April	7.22	11.20
7th May	7.45	11.55
14th May	7.12	11.05
21st May	7.29	11.05
28th May	7.36	11.56
4th June	7.73	
11th June	7.06	
(12th June, 1936)	6.82	8.84

There have occurred somewhat wider fluctuations in raw American prices the trend of which during the next few weeks will be subject to weather reports from the American belt. Only a few bales of West Indian Sea Island have been sold and prices have remained firm.

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—

	Pence per lb.
28th April	10 3/16
5th May	10 3/8
13th May	10 5/16
19th May	10 5/16
26th May	10 1/8
2nd June	9 13/16
9th June	9 3/16
(10th June, 1936)	7 5/16

There have been heavy fluctuations in prices since our last report and despite continued improvement in the statistical position the tone of the market has been easier. According to *Messrs. Symington and Wilson* the causes of the movement may be summarised as follows : uncertainties regarding the future price of gold ; the effects of Mr. Chamberlain's Budget proposals ; labour troubles ; political uncertainty ; and the imposition by Germany of an import duty on all crude rubber. According to the *American Questionnaire* consumption for the first four months of this year shows an increase of 13.3 per cent. over the same period in 1936.

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COCOA.—During the past month the cocoa market continued on its downward trend and it is quite evident that consumers have been heavy buyers on all recent declines which now places them in a rather comfortable position for their immediate needs. With the approaching summer and dullness in the chocolate industry, manufacturers will undoubtedly adhere to scale down buying only, so that, for the time being, a trading market may be expected with the major trend still downward.—(*By courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

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LIME PRODUCTS.—*Lime Oil.*—Small supplies of Handpressed are available at 40*s.* per lb. Distilled continues quiet with sellers asking 25*s.* per lb. *Lime Juice.*—Concentrated continues in slow demand at about £5 15*s.* Raw is also quiet with the value unchanged at 2*s.* 3*d.* to 2*s.* 6*d.* per gallon. —(*West India Committee Circular*, 20th May, 1937.)

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BANANAS.—According to the *West India Committee Circular* for 20th May Jamaicas continue in good demand at £18 15*s.* per ton delivered London and £18 10*s.* nearest station Provinces. Brazilians are £2 higher at £16 delivered London and £17 delivered Provinces.